

A Revision of the Mite Family Phytoseiidae in Japan (Acari, Gamasina), with Remarks on its Biology

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The classification of the mite family Phytoseiidae in Japan is revised. The 77 species recognized from Japan are assigned to three subfamilies, five tribes, nine genera, and 11 subgenera. Moreover, three large subgenera are divided into a total of 16 different species groups. A new tribe, Indoseiulini, is proposed, *Okiseius* Ehara, 1967 is reduced to a subgenus of *Amblyseius*, and three new species, *Amblyseius* (*Proprioseiopsis*) *nemotoi*, *Typhlodromus* (*Typhlodromus*) *pseudopyri*, and *T. (T.) armiger*, are described. Additionally, there is a possibility that 'Japanese *Amblyseius cucumeris*', which was recently reported from Saitama Prefecture in a popular book, is not *A. cucumeris* (Oudemans), but *A. paraki* Ehara, a rather common species in Saitama Prefecture. The biology of Japanese phytoseiid mites is also examined, and on this basis the species diversity of the phytoseiid fauna in Japan is interpreted. Finally, relationships between phytoseiid taxa and biological characters are discussed.

Key Words: *Amblyseius* (*Okiseius*), *Amblyseius* (*Proprioseiopsis*) *nemotoi*, biological grouping, classification, Indoseiulini, Japan, keys, new taxa, *Typhlodromus* (*Typhlodromus*) *armiger*, *Typhlodromus* (*Typhlodromus*) *pseudopyri*.

Introduction

About 1600 species belonging to the mite family Phytoseiidae are now known to occur in the world (Chant and McMurtry 1994). The classification of this large family is quite variable among workers. Muma (1961) proposed a number of new genera in the Phytoseiidae, whilst Chant (1965) recognized fewer genera in this family. Since these two works, two schools of thought have developed, sometimes referred to as 'splitters' and 'lumpers.' In addition, Chant and his coworkers made important studies on the idiosomal setal patterns in this family (e.g., Chant and Yoshida-Shaul 1992b). In a recent paper (Ehara *et al.* 1994), 74 species of Japanese phytoseiid mites were assigned to eight genera and seven subgenera. In that classification, for example, the large genus *Amblyseius* comprises 38 Japanese species, of which the subgenus *Amblyseius*, without subdivisions, contains 36 (95%).

Such a situation is inconvenient for economic entomologists who often utilize phytoseiids, and also for taxonomists themselves, even if it is logical. In the present paper, the classification of Japanese Phytoseiidae is revised somewhat, with practicality in mind. The external morphology was explained concisely in an earlier paper (Ehara 1975). However, as in Ehara *et al.* (1994), the setal nomenclature follows that of Chant and Hansell (1971) and Rowell *et al.* (1978). Namely, the idiosomal setae on the dorsum are divided into the dorsocentral (j-setae on podoscutum, J-setae on

opisthoscutum), mediolateral (z-Z), lateral (s-S), and sublateral series (r-R). For each species, the type locality and distribution records and the list of important references including redescrptions are omitted in this paper, but these can be found in Ehara *et al.* (1994). In this paper three new species are described. The measurements are in micrometers, and those of the holotypes are shown in parentheses following the mean.

The type series of all the Japanese phytoseiid species that were previously described by the senior author, and those of the new species described herein, are now retained in the Department of Biology, Faculty of Education, Tottori University, Tottori. However, at least the holotypes will be deposited in the National Science Museum, Tokyo, in the near future.

Key to Subfamilies of Phytoseiidae (Chant and McMurtry 1994, modified)

1. Podoscutum with 4 pairs of setae on lateral area: j3, z2, z4, s4. Amblyseiinae
Podocutum with more than 4 pairs of setae on lateral area. 2
2. Setae Z1, S2, S4, and S5 absent. Phytoseiinae
At least one of setae Z1, S2, S4, and S5 present. Typhlodrominae

Subfamily **Amblyseiinae** Muma, 1961

Amblyseiinae Muma, 1961: 273. [Type genus: *Amblyseius* Berlese, 1914]

Key to Tribes of the Subfamily Amblyseiinae in Japan

1. Peritrematic shields fused anteriorly to dorsal shield. Amblyseiini
Peritrematic shields not fused anteriorly to dorsal shield.
..... Indoseiulini tribe nov.

Tribe **Amblyseiini** Muma, 1961

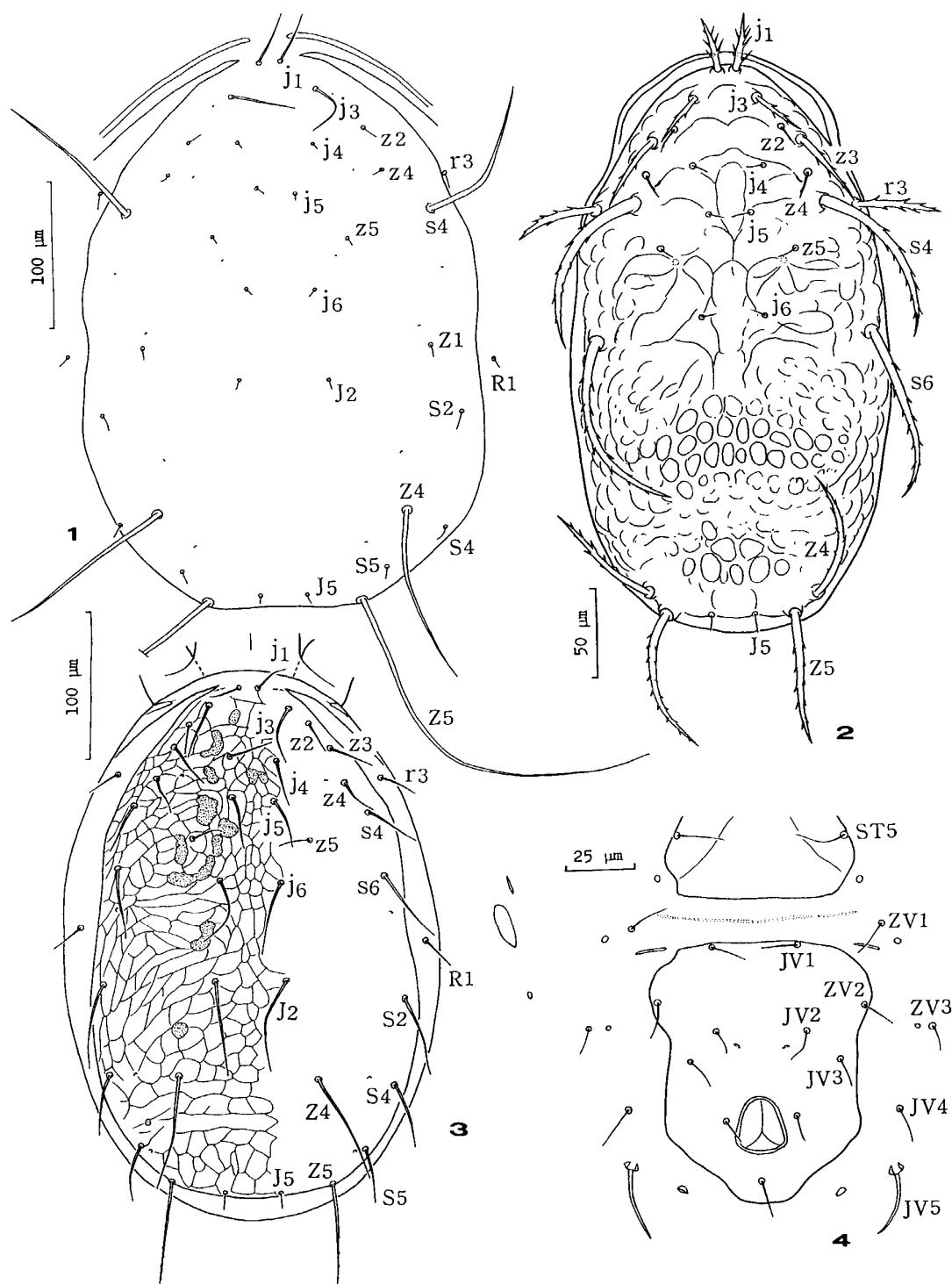
Amblyseiinae Muma, 1961: 273 (in part). [Type genus: *Amblyseius* Berlese, 1914]
Amblyseiini: Wainstein 1962: 26; Schuster and Pritchard 1963: 225.

Key to Genera of the Tribe Amblyseiini in Japan (Females)

1. Opisthoscutum with 1 pair of setae (Z1) on anterolateral area. ... *Paraphytoseius*
Opisthoscutum with 2 or 3 pairs of setae on anterolateral area: (R1), Z1, S2. ... 2
2. Opisthoscutum with 3 pairs of setae on caudal area: Z4, Z5, J5. ... *Amblyseiulella*
Opisthoscutum with 4 or 5 setae on caudal area: (S4), S5, Z4, Z5, J5.
..... *Amblyseius*

Genus **Amblyseius** Berlese, 1914

Amblyseius Berlese, 1914: 143. [Type species: *Zercon obtusus* Koch, 1839, by original designation]



Figs 1-3. Dorsum of phytoseiid mites (♀). 1, *Amblyseius* (*Amblyseius*) *kokufuensis*; 2, *Phytoseius* (*Dubininellus*) *blakistoni*; 3, *Typhlodromus* (*Anthoseius*) *bambusae*. Fig. 4. Posterior ventral surface of *T. (A.) serrulatus* (♀).

Female: Podoscutum with 4 pairs of setae on lateral area; opisthoscutum with 4 or 5 (rarely 6) setae along each lateral margin: Z1, S2, (S4), S5, Z5, (R1).

Key to Subgenera of the Genus *Amblyseius* in Japan (Females)

1. Seta J2 present.....2
Seta J2 absent.4
2. Two or all 3 pairs of preanal setae more or less in a transverse line on anterior part of preanal region.*Euseius*
Two or all 3 pairs of preanal setae not in a transverse line on anterior part of preanal region.3
3. Seta Z5 noticeably longer than half of width of dorsal shield.*Amblyseius*
Seta Z5 at most half as long as width of dorsal shield.*Neoseiulus*
4. Seta S4 present.*Proprioiseiopsis*
Seta S4 absent.5
5. Seta R1 anterior to indentation on dorsal shield.*Okiseius*
Seta R1 on interscutal membrane; dorsal shield without indentation.
..... *Kampimodromellus*

Subgenus *Neoseiulus* Hughes, 1948

Neoseiulus Hughes, 1948: 141. [Type species: *Neoseiulus barkeri* Hughes, 1948, by original designation]

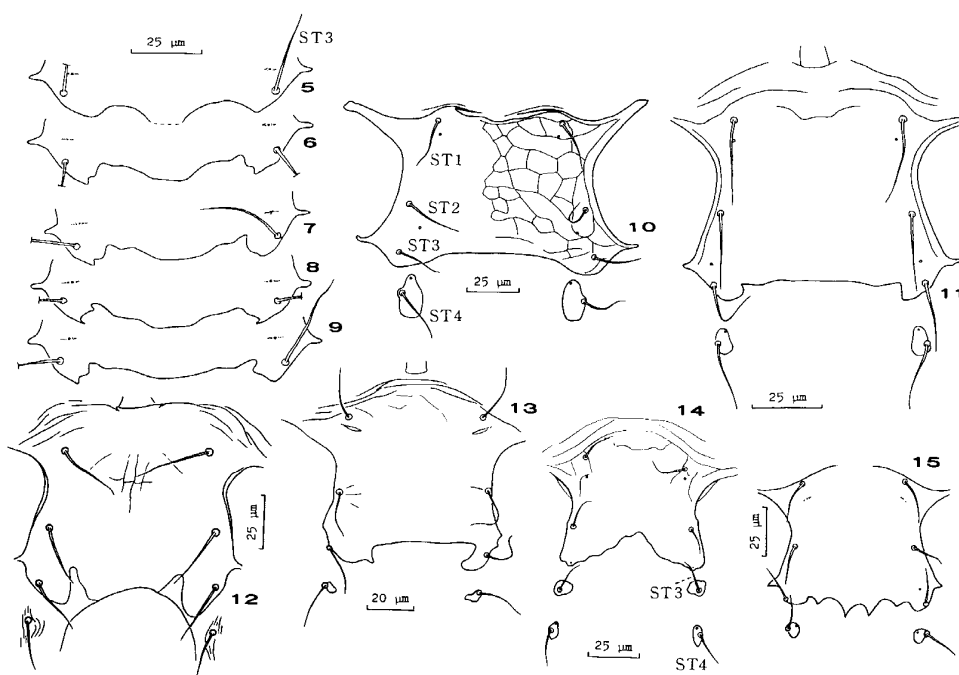
Amblyseius (*Typhlodromalus*) Muma, 1961: 288.

Typhlodromips DeLeon, 1965: 23.

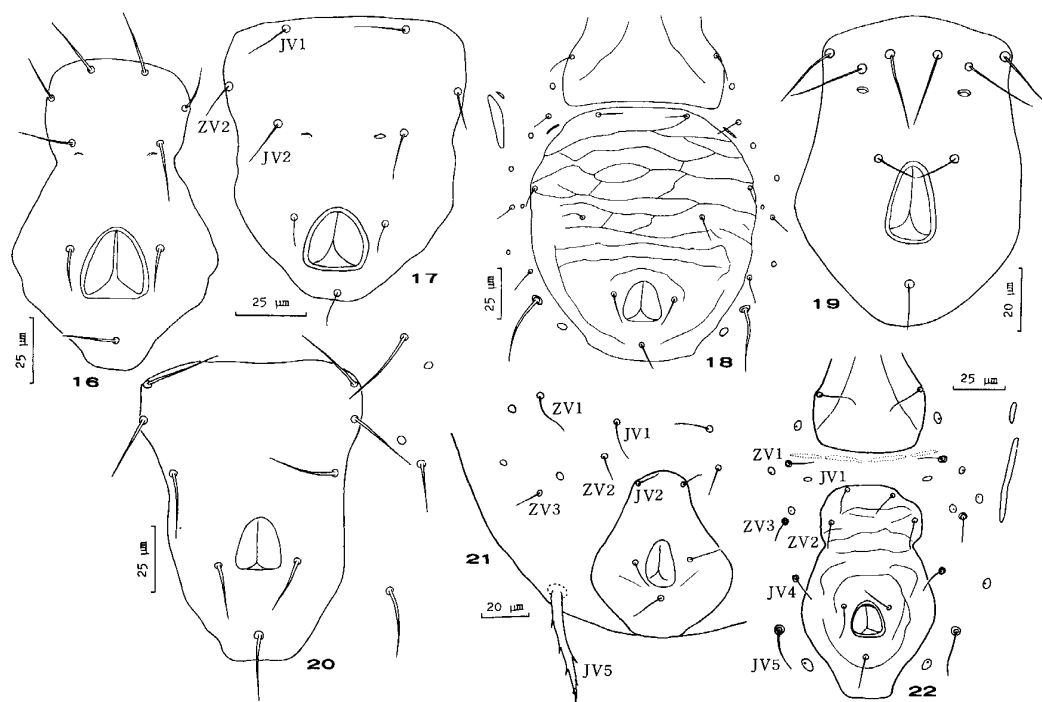
Female: Seta J2 present. Seta Z5 at most half as long as width of dorsal shield. Ventrianal shield not oval in shape. Legs I, II, and III with or without macrosetae; these macrosetae scarcely discernible in some species. Leg IV with 1 or more macrosetae.

Key to Species Groups of the Subgenus *Neoseiulus* in Japan (Females)

1. Setae j4 to j6 and J2 longer than distances between their bases.
.....*womersleyi* species group
Setae j4 to j6 and J2 shorter than distances between their bases.2
2. All 3 pairs of preanal setae and pores on anterior one-third to two-fifths of preanal region.*ezoensis* species group
At least 1 pair of preanal setae and pores not on anterior one-third to two-fifths of preanal region.3
3. Setae j1, j3, s4, (S2), Z4, and Z5 noticeably longer than remaining setae on dorsal shield.4
Some of setae j3, s4, Z4, and Z5 noticeably longer than remaining setae on dorsal shield.5
4. Setae j1, j3, s4, Z4, and Z5 noticeably longer than remaining setae on dorsal shield.*rademacheri* species group
Setae j1, j3, s4, Z4, Z5, and S2 noticeably longer than remaining setae on dorsal shield.*morii* species group



Figs 5-15. Sternal shields (♀). 5-9, *Amblyseius* (*Amblyseius*) *eharai*, partly shown; 10, *A. (A.) ishizuchiensis*; 11, *A. (A.) orientalis*; 12, *A. (Euseius) sojaensis*; 13, *Phytoseius* (*Dubininellus*) *blakistoni*; 14, *Kuzinellus yokogawae*; 15, *Typhlodromus* (*Anthoseius*) *serrulatus*.



Figs 16-22. Ventrianal shields and their surrounding area (♀). 16, *Amblyseius* (*Amblyseius*) *eharai*; 17, *A. (A.) orientalis*; 18, *A. (Neoseiulus) inabanus*; 19, *A. (Euseius) finlandicus*; 20, *Amblyseiulella amanoi*; 21, *Phytoseius* (*Dubininellus*) *blakistoni*; 22, *Paraseiulus soleiger*.

5. Sternal shield longer than wide. *paspalivorus* species group
Sternal shield about as wide as long, or wider than long.6
6. Sternal shield trilobate posteriorly. *japonicus* species group
Sternal shield with posterior margin nearly straight or slightly concave.7
7. Leg IV with only 1 macroseta: basitarsus. *koyamanus* species group
Leg IV with 3 macrosetae.8
8. Tibia IV and basitarsus IV each with 1 macroseta. *paraki* species group
Tibia IV without macrosetae; basitarsus IV with 2 macrosetae.
..... *makuwa* species group

***womersleyi* species group**

Amblyseius womersleyi group Schicha, 1987: 26.

[Exemplar species: *Amblyseius womersleyi* Schicha, 1975]

Most setae on dorsal shield longer than distances between their bases. Leg IV with only 1 macroseta: basitarsus.

1. *Amblyseius* (*Neoseiulus*) *womersleyi* Schicha, 1975

Amblyseius womersleyi Schicha, 1975: 101, figs 1-9; Ehara and Amano 1993: 8, fig. 4.

Typhlodromus longispinosus Evans: Ehara 1958: 55, figs 4-6.

Amblyseius longispinosus: Ehara 1961: 95, fig. 5.

Amblyseius (*Amblyseius*) *longispinosus*: Ehara 1966: 21; Ehara 1977: 36.

Neoseiulus longispinosus: Moraes *et al.* 1986: 85 (in part).

Amblyseius (*Amblyseius*) *womersleyi*: Ehara *et al.* 1994: 123.

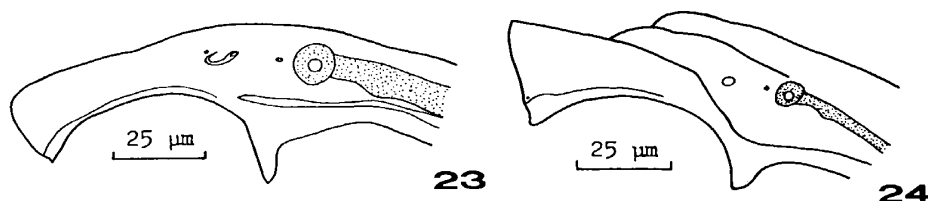
***ezoensis* species group**

[Exemplar species: *Amblyseius* (*Amblyseius*) *ezoensis* Ehara, 1967]

Female: Ventrianal shield with 3 pairs of preanal setae near anterior margin. Sternal shield without posteromedian lobe. Spermatheca with cervix flat, cup-shaped.

Key to Species of the *ezoensis* Species Group in Japan (Females)

1. Setae s4, Z4, and Z5 all much longer and thicker than the other setae on dorsal shield. *ezoensis*



Figs 23, 24. Peritrematic shields (♀). 23, *Amblyseius* (*Neoseiulus*) *haimatus*; 24, *A.* (*Amblyseius*) *ishizuchiensus*.

Only seta Z5 much longer and thicker than the other setae on dorsal shield. ...
 *hinoki*

2. *Amblyseius* (*Neoseiulus*) *ezoensis* Ehara, 1967

Amblyseius (*Amblyseius*) *ezoensis* Ehara, 1967b: 223, figs 45-49; Ehara 1972: 167, figs 116, 117; Ehara *et al.* 1994: 127.

Typhlodromalus ezoensis: Moraes *et al.* 1986: 129.

3. *Amblyseius* (*Neoseiulus*) *hinoki* Ehara, 1972

Amblyseius (*Amblyseius*) *hinoki* Ehara, 1972: 165, figs 111-115; Ehara *et al.* 1994, p. 126.

Typhlodromalus hinoki: Moraes *et al.* 1986: 129.

Amblyseius hinoki: Ehara 1993: 194, figs 94-1, 94-2(right).

rademacheri species group

[Exemplar species: *Amblyseius rademacheri* Dosse, 1958]

Female: Setae j1, j3, s4, Z4, and Z5 much longer than remaining setae on dorsal shield.

Key to Species of the *rademacheri* Species Group in Japan (Females)

1. Dorsal shield nearly smooth, or reticulate only along lateral margins.2
 Dorsal shield wholly reticulate.3
2. Seta s4 more than twice as long as z4 and S2.*ishikawai*
 Seta s4 less than twice as long as z4 and S2.*oguroi*
3. Spermatheca with cup-shaped cervix.*rademacheri*
 Spermatheca with horn-shaped cervix.*ainu*

4. *Amblyseius* (*Neoseiulus*) *rademacheri* Dosse, 1958

Amblyseius rademacheri Dosse, 1958: 44, figs 1-5; Ehara 1959: 288, figs 6-11; Ehara 1961: 96; Ehara 1962: 53; Ryu and Ehara 1992: 727, figs 15-23.

Amblyseius (*Amblyseius*) *rademacheri*: Ehara 1966: 23; Ehara 1977: 37; Ehara *et al.* 1994: 130.

Amblyseius (*Typhlodromips*) *rademacheri*: Karg 1971: 185, figs 129e, 132h.

Typhlodromips rademacheri: Moraes *et al.* 1986: 145.

5. *Amblyseius* (*Neoseiulus*) *ishikawai* Ehara, 1972

Amblyseius (*Amblyseius*) *ishikawai* Ehara, 1972: 158, figs 83-91; Ehara *et al.* 1994:

130.

Typhlodromips ishikawai: Moraes *et al.*, 1986: 141.6. *Amblyseius* (*Neoseiulus*) *oguroi* Ehara, 1964*Amblyseius oguroi* Ehara, 1964: 384, figs 17-23.*Amblyseius* (*Amblyseius*) *oguroi*: Ehara 1966: 21; Ehara *et al.* 1994: 124.*Typhlodromips oguroi*: Moraes *et al.* 1986: 144.7. *Amblyseius* (*Neoseiulus*) *ainu* Ehara, 1967
(Fig. 25)*Amblyseius* (*Amblyseius*) *ainu* Ehara, 1967b: 218, figs 21-27; Ehara 1972: 156, fig. 77;
Ehara *et al.* 1994: 125.*Typhlodromips ainu*: Moraes *et al.* 1986: 135.***morii* species group**[Exemplar species: *Amblyseius morii* Ehara, 1967]

Female: Setae j1, j3, s4, Z4, Z5, and S2 noticeably longer than the other setae on dorsal shield. Seta Z5 approximately as long as half of width of dorsal shield.

8. *Amblyseius* (*Neoseiulus*) *morii* Ehara, 1967*Amblyseius* (*Amblyseius*) *morii* Ehara, 1967b: 219, figs 28-34; Ehara 1972: 156, fig. 78;
Ehara *et al.* 1994: 123.*Amblyseius morii*: Moraes *et al.* 1986: 22.

This species is characterized by having seta S2 about twice the length of Z1, and by the conspicuous ventrianal pores just behind the posterior preanal setae (JV2).

A mite was illustrated as '*A. morii*' by Denmark and Muma (1989). However, it is almost certain that their mite is not conspecific with *A. morii*, because of the relative lengths of setae Z1 and S2 and the placement of the ventrianal pores (Ehara *et al.* 1994).***paspalivorus* species group***Amblyseius paspalivorus* group Schicha and Corpuz-Raros, 1992: 22.[Exemplar species: *Typhlodromus paspalivorus* DeLeon, 1957]

Female: Dorsal shield slender and parallel-sided, reticulate. One (Z5) or two (Z4 and Z5) setae serrate, much longer and stouter than the other setae on dorsal shield. Sternal shield longer than wide.

Key to Species of the *paspalivorus* Species Group in Japan (Females)

1. Setae Z4 and Z5 both much longer than the other setae on dorsal shield.
 *californicus*
 Only seta Z5 much longer than the other setae on dorsal shield. *inabanus*

9. *Amblyseius* (*Neoseiulus*) *californicus* (McGregor, 1954)

Typhlodromus californicus McGregor, 1954: 89, figs 1-4.

Typhlodromus chilensis Dosse, 1958: 55, figs 11-15.

Amblyseius chilensis: González and Schuster 1962: 10, fig. 3; Ehara 1964: 383, figs 9-16.

Amblyseius (*Amblyseius*) *chilensis*: Ehara 1966: 20; Ehara 1977: 34.

Cydnodromus californicus: Athias-Henriot 1977: 62, figs 10, 13, 14, 18, 27-29.

Neoseiulus californicus: Moraes *et al.* 1986: 73.

Amblyseius californicus: Ehara and Amano 1993: 10, fig. 5.

Amblyseius (*Amblyseius*) *californicus*: Ehara *et al.* 1994: 126.

10. *Amblyseius* (*Neoseiulus*) *inabanus* Ehara, 1972
(Figs 18, 37)

Amblyseius (*Amblyseius*) *inabanus* Ehara, 1972: 146, figs 36-41; Ehara and Yokogawa 1977: 52, fig. 9; Ehara *et al.* 1994: 126.

Neoseiulus inabanus: Moraes *et al.* 1986: 84.

japonicus species group

Amblyseius japonicus group Schicha, 1987: 26.

[Exemplar species: *Typhlodromus japonicus* Ehara, 1958]

Female: Sternal shield trilobate posteriorly. Spermatheca with tubular, coiled cervix.

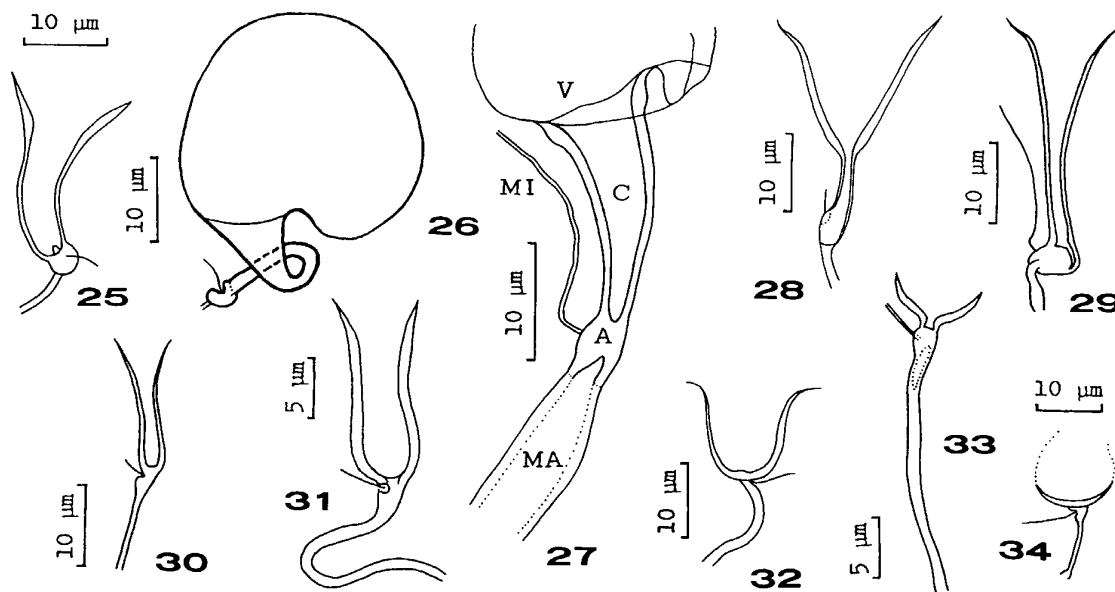
11. *Amblyseius* (*Neoseiulus*) *japonicus* (Ehara, 1958)
(Fig. 26)

Typhlodromus japonicus Ehara, 1958: 56, figs 7-9.

Amblyseius japonicus: Ehara 1961: 95, fig. 3; Schicha 1980: 28, figs 48-54; Schicha 1987: 94, pl. 47.

Amblyseius (*Amblyseius*) *japonicus*: Ehara 1966: 21; Ehara 1977: 36; Ehara *et al.* 1994: 125.

Typhlodromalus japonicus: Moraes *et al.* 1986: 130.



Figs 25-34. Spermathecae. 25, *Amblyseius (Amblyseius) ainu*; 26, *A. (N.) japonicus*; 27, *A. (N.) barkeri* (A, atrium; C, cervix; MA, major duct; MI, minor duct; V, vesicle); 28, *A. (N.) haimatus*; 29, *A. (Amblyseius) eharai*; 30, *A. (A.) orientalis*; 31, *A. (A.) indocalami*; 32, *A. (A.) kaguya*; 33, *Amblyseiulella amanoi*; 34, *Paraphytoseius multidentatus*.

***koyamanus* species group**

[Exemplar species: *Amblyseius (Amblyseius) koyamanus* Ehara and Yokogawa, 1977]

Female: Setae on dorsal shield except Z5 similar in length. Leg IV with only 1 macroseta: basitarsus.

Key to Species of the *koyamanus* Species Group in Japan (Females)

1. Dorsal shield almost smooth.....*barkeri*
Dorsal shield wholly reticulate.2
2. Seta Z4 noticeably longer than S4.*koyamanus*
Seta Z4 approximately as long as S4.*hirotae*

12. *Amblyseius (Neoseiulus) barkeri* (Hughes, 1948) (Figs 27, 44)

Neoseiulus barkeri Hughes, 1948: 141, figs 200-206; Hughes 1976: 343, figs 391-394.
Amblyseius (Amblyseius) barkeri: Ehara 1972: 147, figs 42-48; Ehara 1977: 34; Ehara *et al.*, 1994: 124.
Neoseiulus barkeri: Moraes *et al.* 1986: 70.

13. *Amblyseius* (*Neoseiulus*) *koyamanus* Ehara and Yokogawa, 1977

Amblyseius (*Amblyseius*) *koyamanus* Ehara and Yokogawa, 1977: 50, figs 1-8; Ehara 1985: 118, figs 13, 14; Ehara *et al.* 1994: 125.

Neoseiulus koyamanus: Moraes *et al.* 1986: 85.

14. *Amblyseius* (*Neoseiulus*) *hirotæ* Ehara, 1985

Amblyseius (*Amblyseius*) *hirotæ* Ehara, 1985: 119, figs 15-24.

Neoseiulus hirotæ: Moraes *et al.* 1986: 83.

***paraki* species group**

[Exemplar species: *Amblyseius paraki* Ehara, 1967]

Female: Some or all of setae Z4, Z5, and s4 longer than the other setae on dorsal shield. Leg IV with 3 macrosetae, on genu, tibia, and basitarsus.

Key to Species of the *paraki* Species Group in Japan (Females)

1. Seta Z5 at least twice the length of Z4.....2
 Seta Z5 less than twice the length of Z4.4
2. Seta Z5 approximately twice the length of Z4.3
 Seta Z5 longer than twice the length of Z4.....*neoparaki*
3. Dorsal shield wholly reticulate.*alpicola*
 Dorsal shield reticulate only along lateral margins.*okinawanus*
4. Seta Z4 shorter than Z5.5
 Seta Z4 approximately as long as Z5.*yanoi*
5. Seta S4 not longer than distance between its base and that of Z4.*haimatus*
 Seta S4 longer than distance between its base and that of Z4.*paraki*

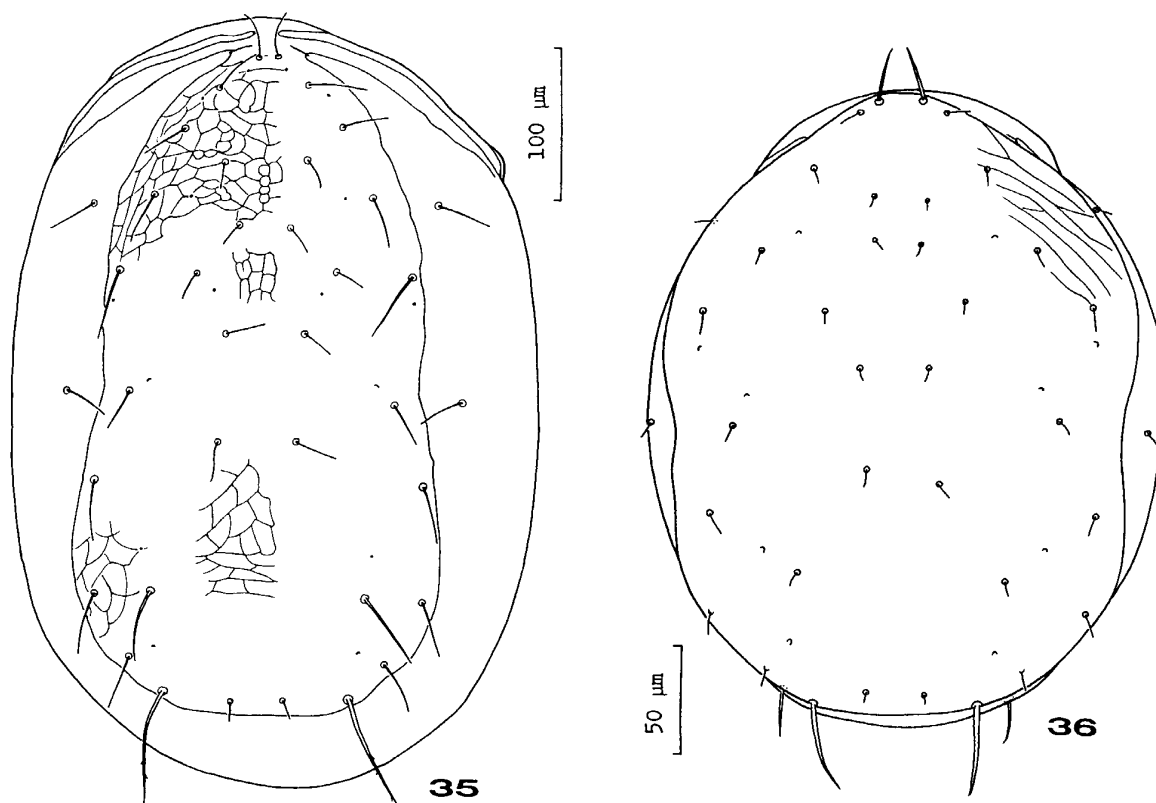
15. *Amblyseius* (*Neoseiulus*) *paraki* Ehara, 1967

(Fig. 35)

Amblyseius (*Amblyseius*) *paraki* Ehara, 1967b: 216, figs 16-20; Ehara and Yokogawa 1977: 52, figs 10-16; Ehara *et al.* 1994: 126.

Neoseiulus paraki: Moraes *et al.* 1986: 92.

Recently '*Amblyseius* (*Neoseiulus*) *cucumeris* (Oudemans)' was reported from Japan only under the Japanese name 'kukumerisu-kaburidani' in a popular book (Nemoto 1995). The material on which Nemoto's record was based was collected in Saitama Prefecture by Dr. M. W. Sabelis, University of Amsterdam. This identification was made by European acarologists who were probably unfamiliar with Japanese phytoseiids. On the other hand, specimens of true *A. cucumeris* have not been collected in Japan by Japanese workers including the present authors. In spite of repeated surveys in Saitama Pref. from 1994 to 1996 by the junior author and his



Figs 35, 36. Dorsum (♀). 35, *Amblyseius (Neoseiulus) paraki*; 36, *Amblyseius (Euseius) ovalis*.

students, no specimens of this species have as yet been taken there.

With respect to such 'Japanese *A. cucumeris*,' the present authors consider that there are the following two possibilities: either is a misidentification or an accidental introduction of *A. cucumeris* into Saitama Pref. on flowers, vegetables, or fruits imported from Europe or elsewhere.

The specimens of '*A. cucumeris*' taken by Sabelis were lost, unfortunately (Dr. Sabelis' personal communication to Dr. T. Gotoh). However, it is probable that the 'Japanese *A. cucumeris*' is actually a related species, *A. paraki*, which is rather common in Saitama Pref. The female of *A. paraki* is apparently similar to that of *A. cucumeris* in dorsal idiosomal setae, but it is distinguished from the latter by the longer peritremes, the dentition of the chelicera, and the shape of the spermatheca.

16. *Amblyseius (Neoseiulus) neoparaki* Ehara, 1972

Amblyseius (Amblyseius) neoparaki Ehara, 1972: 153, figs 63-69; Ehara *et al.* 1994: 124.
Neoseiulus neoparaki: Moraes *et al.* 1986: 90.

17. *Amblyseius (Neoseiulus) alpicola* Ehara, 1982

Amblyseius (Amblyseius) alpicola Ehara, 1982: 40, figs 1-9; Ehara *et al.* 1994: 125.

Typhlodromips alpicola: Moraes *et al.* 1986: 136.

18. *Amblyseius* (*Neoseiulus*) *okinawanus* Ehara, 1967

Amblyseius (*Amblyseius*) *okinawanus* Ehara, 1967a: 72, figs 17-24; Ehara 1977: 37;
Ehara and Hamaoka 1980: 6, figs 9-11; Ehara *et al.* 1994: 124.
Neoseiulus okinawanus: Moraes *et al.* 1986: 91.

19. *Amblyseius* (*Neoseiulus*) *yanoi* Ehara, 1972

Amblyseius (*Amblyseius*) *yanoi* Ehara, 1972: 151, figs 54-62; Ehara 1977: 38; Ehara *et al.* 1994: 125.
Neoseiulus yanoi: Moraes *et al.* 1986: 100.

20. *Amblyseius* (*Neoseiulus*) *haimatus* Ehara, 1967
(Figs 23, 28)

Amblyseius (*Amblyseius*) *haimatus* Ehara, 1967b: 214, figs 8-12; Ehara 1972: 149, figs 49-53; Ehara *et al.* 1994: 126.
Neoseiulus haimatus: Moraes *et al.* 1986: 83.

***makuwa* species group**

[Exemplar species: *Amblyseius* (*Amblyseius*) *makuwa* Ehara, 1972]

Female: Seta Z5 noticeably longer than Z4, the latter much longer than s4; j1 and j3 much shorter, but larger than remaining setae on dorsal shield. Spermatheca with horn-shaped cervix. Basitarsus IV with 2 macrosetae, tibia IV without macrosetae, genu IV with 1 macroseta.

21. *Amblyseius* (*Neoseiulus*) *makuwa* Ehara, 1972

Amblyseius (*Amblyseius*) *makuwa* Ehara, 1972: 154, figs 70-74; Ehara and Hamaoka 1980: 6, fig. 8; Ehara *et al.* 1994: 124.
Neoseiulus makuwa: Moraes *et al.* 1986: 87.
Amblyseius makuwa: Ehara and Amano 1993: 6, fig. 3.

Subgenus *Amblyseius* Berlese, 1914

Amblyseius Berlese, 1914: 143. [Type species: *Zercon obtusus* Koch, 1839, by original designation]

Female: Seta J2 present. All or some of setae j1, j3, s4, Z4, and Z5 much longer than the other setae on dorsal shield; Z5 whip-like, noticeably longer than half of

width of dorsal shield. Ventrianal shield not oval in shape.

Key to Species Groups of the Subgenus *Amblyseius* in Japan (Females)

1. Macroseta on genu IV longer than those on basitarsus and tibia of leg IV.2
Macroseta on genu IV shorter than that on basitarsus IV.3
2. Ventrianal shield vase-shaped, with distinct waist.*largoensis* species group
Ventrianal shield triangular or pentagonal, with at most a slight waist.
..... *obtusus* species group
3. Setae j1, j3, s4, Z4, and Z5 all noticeably longer than the other setae on dorsal shield.*tsugawai* species group
Only setae Z4 and Z5 noticeably longer than the other setae on dorsal shield. ...
..... *ochii* species group

***largoensis* species group**

Amblyseius largoensis group McMurtry and Moraes, 1984: 29.

[Exemplar species: *Amblyseiopsis largoensis* Muma, 1955]

Female: Setae j1, j3, s4, Z4, and Z5 very long; remaining dorsal idiosomal setae minute. Ventrianal shield vase-shaped, with lateral margins constricted near level of preanal pores and with anterior portion narrower than posterior portion. Macroseta on genu IV longer than that on tibia IV, and latter longer than that on basitarsus IV.

Key to Species of the *largoensis* Species Group in Japan (Females)

1. Sternal shield with median posterior lobe.*eharai*
Sternal shield without median posterior lobe.*kokufuensis*

22. *Amblyseius* (*Amblyseius*) *eharai* Amitai and Swirski, 1981
(Figs 5-9, 16, 29, 42)

Amblyseius eharai Amitai and Swirski, 1981: 60, figs 1-3, 6-8, 12-13; McMurtry and Moraes 1984: 35, figs 19, 23; Ehara and Amano 1993: 16, fig. 8.

Amblyseius largoensis Muma: Ehara 1959: 293, figs 17-18; Ehara 1961: 96, fig. 8; Ehara 1962: 54.

Amblyseius deleoni Muma and Denmark: Ehara 1977: 34, figs 1-2.

Amblyseius (*Amblyseius*) *eharai*: Ehara *et al.* 1994: 127, figs 1-7.

23. *Amblyseius* (*Amblyseius*) *kokufuensis* Ehara and Kato, 1994
(Fig. 1)

Amblyseius (*Amblyseius*) *kokufuensis* Ehara and Kato *in* Ehara *et al.* 1994: 128, figs 8-15.

***obtusus* species group**

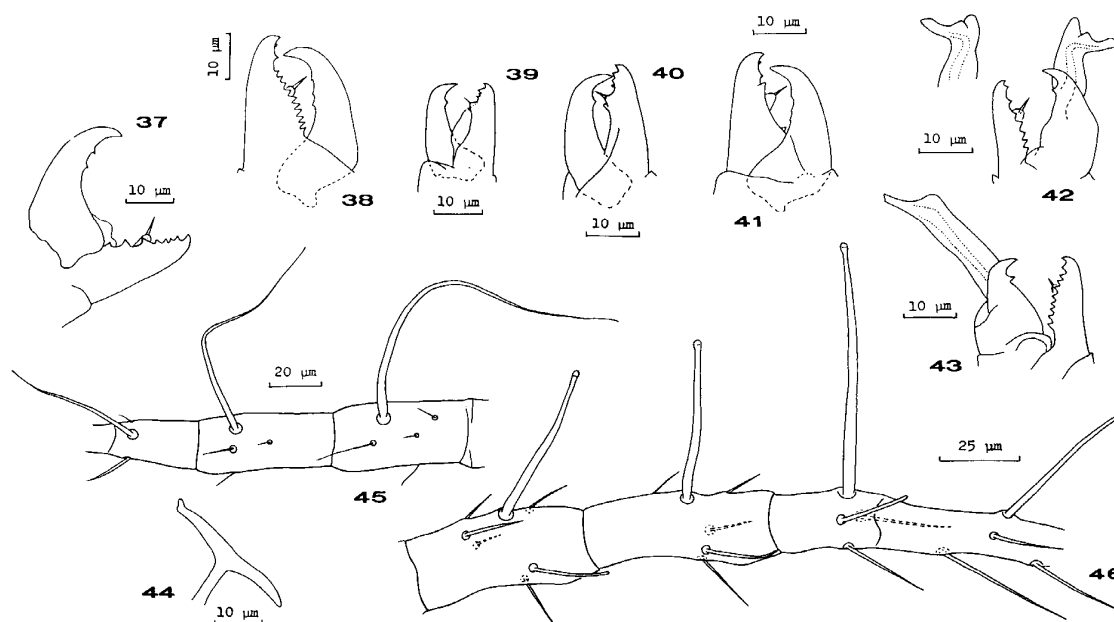
Typhlodromus obtusus group Chant, 1959b: 71 (in part).

[Exemplar species: *Zercon obtusus* Koch, 1839]

Female: Setae j1, j3, s4, Z4, and Z5 very long, remaining dorsal idiosomal setae minute. Ventrianal shield triangular or pentagonal, with at most a slight waist. Macroseta on genu IV longer than that on tibia IV, latter either longer or shorter than that on basitarsus IV.

Key to Species of the *obtusus* Species Group in Japan (Females)

1. Ventrianal shield wider than long.*ishizuchiensis*
Ventrianal shield longer than, or about as long as wide.2
2. Macroseta on tibia IV shorter than that on basitarsus IV.3
Macroseta on tibia IV longer than that on basitarsus IV.4
3. Ventrianal pores just behind posterior pair of preanal setae (JV2).*indocalami*
Ventrianal pores between and slightly caudal to posterior pair of preanal setae (JV2).*obtuserellus*
4. Ventrianal pores just behind posterior pair of preanal setae (JV2).*kaguya*
Ventrianal pores not as above.5
5. Spermatheca with cervix constricted in middle.*firmus*
Spermatheca with cervix not constricted.6
6. Spermatheca with atrium directly proximal to cervix.7



Figs 37-41. Chelicerae (♀). 37, *Amblyseius* (*Neoseiulus*) *inabanus*; 38, *A. (Amblyseius) tsugawai*; 39, *Paraseiulus soleiger*; 40, *Typhlodromus (Anthoseiulus) viktorovi*; 41, *T. (A.) vulgaris*. Figs 42, 43. Chelicerae (♂). 42, *Amblyseius (Amblyseius) eharai*; 43, *A. (A.) orientalis*. Fig. 44. Spermatodactyl of *A. (Neoseiulus) barkeri*. Figs 45, 46. Legs IV (♀). 45, *Amblyseius (Amblyseius) kaguya*; 46, *Amblyseiulella amanoi*.

- Spermatheca with atrium embedded in cervix. *neofirmus*
 7. Spermatheca very slender, atrium distinct. *orientalis*
 Spermatheca thick, atrium indistinct. *shiganus*

24. ***Amblyseius* (*Amblyseius*) *ishizuchiensis*** Ehara, 1972
 (Figs 10, 24)

Amblyseius (*Amblyseius*) *ishizuchiensis* Ehara, 1972: 162, figs 97-102; Ehara *et al.* 1994: 127.

Amblyseius ishizuchiensis: Denmark and Muma 1989: 35, figs 158-162.

25. ***Amblyseius* (*Amblyseius*) *indocalami*** Zhu and Chen, 1983
 (Fig. 31)

Amblyseius indocalami Zhu and Chen, 1983a: 385, figs 7-12.

Amblyseius (*Amblyseius*) *indocalami*: Ehara *et al.* 1994: 130, figs 18-26.

26. ***Amblyseius* (*Amblyseius*) *obtuserellus*** Wainstein and Begljarov, 1971

Amblyseius obtuserellus Wainstein and Begljarov, 1971: 1806, fig. 3; Denmark and Muma 1989: 124, figs 660-664.

Amblyseius (*Amblyseius*) *obtuserellus*: Ehara and Yokogawa, 1977: 54, figs 25-31; Wu 1984: 224, figs 12-13; Ehara *et al.* 1994: 132.

27. ***Amblyseius* (*Amblyseius*) *kaguya*** Ehara, 1966
 (Figs 32, 45)

Amblyseius (*Amblyseius*) *kaguya* Ehara, 1966: 12, figs 15-19; Wu 1987: 266, figs 27-32; Ehara *et al.* 1994: 132.

Amblyseius kaguya: Denmark and Muma 1989: 40, figs 191-195.

28. ***Amblyseius* (*Amblyseius*) *firmus*** Ehara, 1967

Amblyseius (*Amblyseius*) *firmus* Ehara, 1967b: 222, figs 40-44; Ehara *et al.* 1994: 132.

Amblyseius firmus: Denmark and Muma 1989: 43, figs 207-211.

29. ***Amblyseius* (*Amblyseius*) *neofirmus*** Ehara and Okada, 1994

Amblyseius (*Amblyseius*) *neofirmus* Ehara and Okada *in* Ehara *et al.* 1994: 133, figs 31-38.

30. *Amblyseius* (*Amblyseius*) *orientalis* Ehara, 1959
(Figs 11, 17, 30, 43)

Amblyseius orientalis Ehara, 1959: 291, figs 14-16; Ehara 1961: 96, fig. 7; Ehara 1962: 53, figs 1-5; Chen *et al.* 1984: 345, fig. 14 (44); Denmark and Muma 1989: 42, figs 201-206; Ehara and Amano 1993: 18, fig. 9.

Amblyseius (*Amblyseius*) *orientalis*: Ehara 1966: 23; Ehara and Yokogawa 1977: 56, fig. 32; Ehara *et al.* 1994: 133, figs 27-30.

31. *Amblyseius* (*Amblyseius*) *shiganus* Ehara, 1972

Amblyseius (*Amblyseius*) *shiganus* Ehara, 1972: 160, figs 92-96; Ehara *et al.* 1994: 133.
Amblyseius shiganus: Denmark and Muma 1989: 47, figs 232-236.

***tsugawai* species group**

[Exemplar species: *Amblyseius tsugawai* Ehara, 1959]

Female: Setae j1, j3, s4, Z4, and Z5 much longer than the other setae on dorsal shield. Macroseta on genu IV shorter than that on basitarsus IV, and longer than that on tibia IV.

32. *Amblyseius* (*Amblyseius*) *tsugawai* Ehara, 1959
(Fig. 38)

Amblyseius tsugawai Ehara, 1959: 290, figs 12, 13; Ehara 1961: 95, fig. 6; Ehara 1964: 386, figs 24-27; Chen *et al.* 1984: 341, fig. 14(40); Ehara and Amano 1993: 14, fig. 7.

Amblyseius (*Amblyseius*) *tsugawai*: Ehara 1966: 23; Ehara 1967b: 221, figs 35-39; Ehara 1972: 157, fig. 79; Ehara *et al.* 1994: 130.

Typhlodromips tsugawai: Moraes *et al.* 1986: 151.

***ochii* species group**

[Exemplar species: *Amblyseius* (*Amblyseius*) *ochii* Ehara and Yokogawa, 1977]

Female: Setae Z4 and Z5 noticeably longer than the other setae on dorsal shield. Seta S2 noticeably longer than Z1. Macroseta on genu IV shorter than that on basitarsus IV, and approximately as long as that on tibia IV.

33. *Amblyseius* (*Amblyseius*) *ochii* Ehara and Yokogawa, 1977

Amblyseius (*Amblyseius*) *ochii* Ehara and Yokogawa, 1977: 54, figs 17-24; Ehara *et al.* 1994: 124.

Amblyseius ochii: Chen *et al.* 1984: 333, fig. 14(30).

Neoseiulus ochii: Moraes *et al.* 1986: 91.

Subgenus *Euseius* Wainstein, 1962

Amblyseius (*Amblyseius*) section *Euseius* Wainstein, 1962a: 15. [Type species: *Seiulus finlandicus* Oudemans, 1915, by original designation]
Euseius: DeLeon, 1966: 86.

Female: Seta J2 present. Peritreme short, extending forward at most to level of j3. Sternal shield trilobate posteriorly. Ventrianal shield nearly oval, widest at level of anus, with lateral margins slightly concave anteriorly; all (3 pairs) or 2 pairs of preanal setae more or less aligned in transverse row on anterior part of preanal region. Chelicera with fixed digit dentate only on distal portion.

Key to Species of the Subgenus *Euseius* in Japan (Females)

1. Three pairs of preanal setae nearly in a transverse line; peritreme very short, not extending beyond level of seta z4. *finlandicus*
 Two mesial pairs of preanal setae nearly in a transverse line; peritreme extending to between setae j3 and z2. 2
2. Seta j1 slightly longer than j3. *sojaensis*
 Seta j1 at least twice the length of j3. *ovalis*

34. *Amblyseius* (*Euseius*) *finlandicus* (Oudemans, 1915) (Fig. 19)

Seiulus finlandicus Oudemans, 1915: 183.

Typhlodromus finlandicus: Nesbitt 1951: 25, pl. 3, pl. 9 (fig. 5), pl. 10 (fig. 12), pl. 11 (fig. 19); Ehara 1958: 53, figs 1-3; Ehara 1961: 95, fig. 4.

Amblyseius finlandicus: Athias-Henriot 1958: 34; Chant and Hansell 1971: 706, figs 1-4.

Typhlodromus (*Amblyseius*) *finlandicus*: Chant 1959b: 67, figs 94, 95.

Typhlodromus (*Typhlodromus*) *finlandicus*: Westerboer and Bernhard 1963: 592, figs 365-376.

Amblyseius (*Amblyseius*) *finlandicus*: Ehara 1966: 24; Ehara 1972: 167; Ehara *et al.* 1994: 123.

Euseius finlandicus: Karg 1971: 178, fig. 125c; Moraes *et al.* 1986: 41.

35. *Amblyseius* (*Euseius*) *sojaensis* Ehara, 1964 (Fig. 12)

Amblyseius sojaensis Ehara, 1964: 381, figs 5-8; Ehara and Amano 1993: 12, fig. 6.

Amblyseius (*Amblyseius*) *sojaensis*: Ehara 1966: 24; Ehara 1972: 168, figs 118-121; Ehara *et al.* 1994: 123.

Euseius sojaensis: Moraes *et al.* 1986: 54.

36. *Amblyseius* (*Euseius*) *ovalis* (Evans, 1953)
(Fig. 36)

Typhlodromus ovalis Evans, 1953: 458, figs 5, 6.

Amblyseius (*Amblyseius*) *ovalis*: Ehara 1966: 24; Ehara 1967a: 74, figs 25-30; Ehara 1970: 58; Ehara *et al.* 1994: 123.

Amblyseius ovalis: Corpuz and Rimando 1966: 122, fig. 5; Schicha 1977: 127, figs 28-34; Schicha and Corpuz-Raros 1992: 41, pl. 18.

Euseius ovalis: Moraes *et al.* 1986: 49.

Subgenus *Proprioseiopsis* Muma, 1961

Proprioseiopsis Muma, 1961: 277. [Type species: *Typhlodromus* (*Amblyseius*) *terrestris* Chant, 1959, by original designation]

Female: Opisthoscutum with setae Z1, S2, Z4, S4, S5, Z5 and J5 (J2 absent). In Japanese species, Z5 at most approximately as long as distance between bases of Z5.

Key to Species of the Subgenus *Proprioseiopsis* in Japan (Females)

1. Seta z4 reaching to base of s4. *scurra*
Seta z4 not reaching to base of s4. *nemotoi*

37. *Amblyseius* (*Proprioseiopsis*) *scurra* Wainstein and Begljarov, 1971

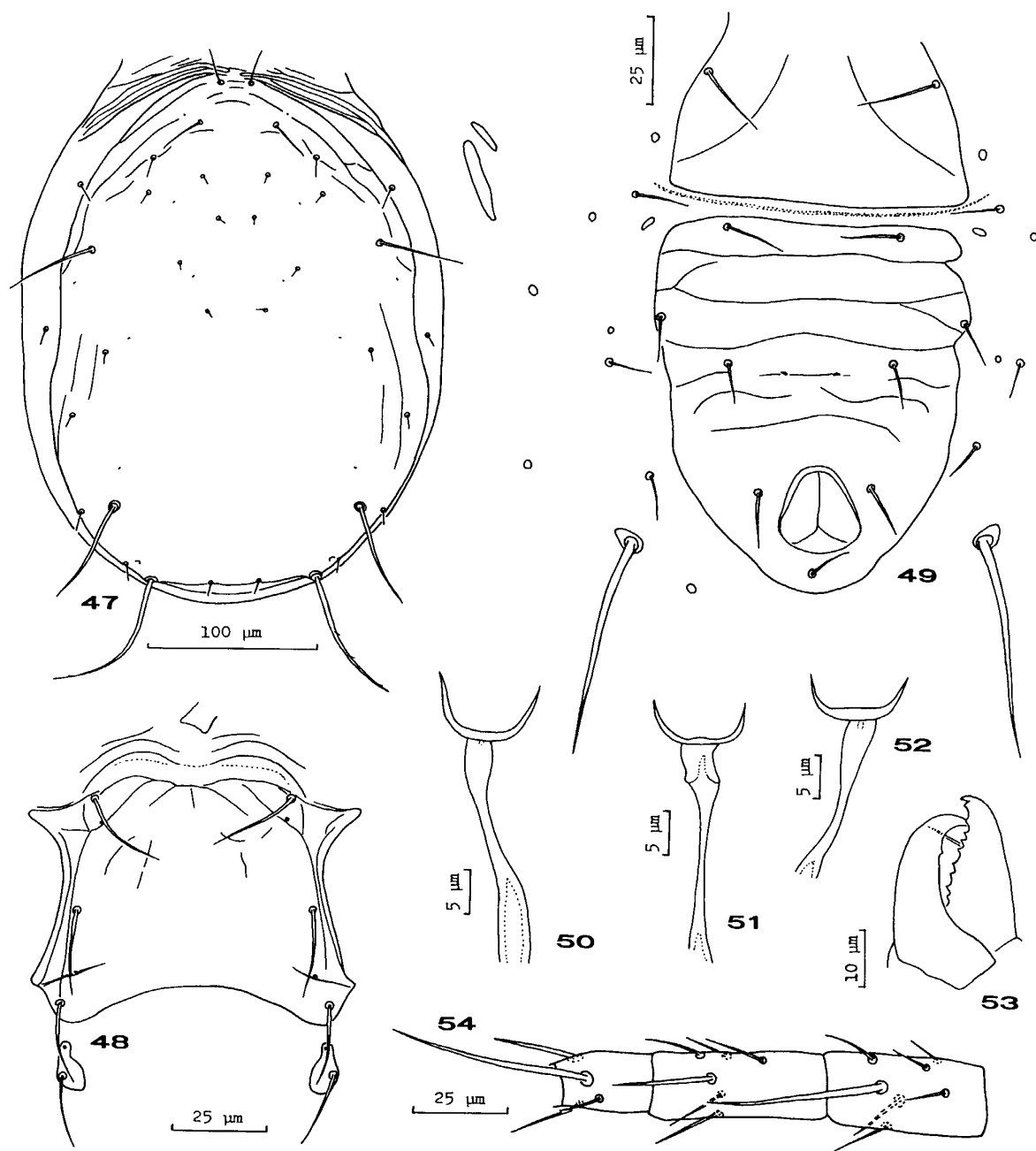
Amblyseius scurra Wainstein and Begljarov, 1971: 1803, fig. 1.

Amblyseius (*Amblyseius*) *scurra*: Ehara 1972: 162, figs 103-110.

Amblyseius (*Proprioseiopsis*) *scurra*: Ehara *et al.* 1994: 135.

38. *Amblyseius* (*Proprioseiopsis*) *nemotoi* Ehara and Amano, sp. nov.
(Japanese name: Saitama-kaburidani)
(Figs 47-54)

Female. Dorsal shield with weak striae along lateral margins, otherwise smooth, with 7 pairs of solenostomes. Setae on dorsal shield: Z5 the longest, sparsely serrate, approximately as long as distance Z5-Z5; s4 and Z4 very long, practically smooth; j1, j3, and z2 much smaller, smooth; remaining setae very small. Setae r3 longer than R1. Peritreme extending anteriorly beyond seta j1; posterior extension of peritrematic shield ending in narrow, apparently semicircular termination. Sternal shield wider than long, with posterior margin concave, bearing 3 pairs of setae; metasternal platelets much longer than wide. Ventrianal shield much longer than wide, approximately as wide as (holotype) or somewhat wider than genital shield, with lateral margins slightly concave; 3 pairs of preanal setae; pair of very small, crescentic pores slightly behind and mediad of setae JV2. Setae JV5 stout, smooth. Two pairs of slender metapodal platelets. Spermatheca with cup-shaped cervix. Fixed digit of



Figs 47-54. *Amblyseius (Proprioseiopsis) nemotoi* sp. nov. (♀). 47, dorsum; 48, sternal shield; 49, posterior ventral surface; 50-52, spermathecae; 53, chelicera; 54, leg IV. [47-50, 52, 54, holotype; 51, 53, paratype]

chelicera with a subapical tooth and 6-8 adjacent teeth; movable digit unidentate. Chaetotaxic formula: genu II, 2-2/1, 2/0-1; genu III, 1-2/1, 2/0-1. Genu and tibia of leg IV each with tapering macroseta; basitarsus IV with 2 tapering macrosetae. Measurements: length of idiosoma 361, width of idiosoma 279; length of dorsal shield 344, width of dorsal shield 232; lengths of setae: j1 20.3 (19.8), j3 29.3 (26.7), j4 5.2 (5.0), j5 5.5 (5.1), j6 7.2 (6.0), J5 7.9 (7.5), z2 14.6 (12.6), z4 10.7 (9.5), z5 5.5 (4.9),

Z1 7.7 (7.3), Z4 69.6 (67.2), Z5 98.1 (98.0), s4 54.8 (52.7), S2 8.7 (8.4), S4 9.5 (9.3), S5 9.8 (9.5), r3 15.5 (15.2), R1 9.9 (8.9), JV5 65.4 (62.0); macrosetae on leg IV: genu 51.1 (46.8), tibia 38.8 (32.0), basitarsus (dorsal) 58.2 (52.5), basitarsus (outer) 24.6 (22.9).

Male. Not known.

Type series. Holotype: ♀, Kuki, Saitama Pref., 28-VIII-1996 (A. Koike), on pear. Paratypes: 1 ♀, 27-VI-1996, other data as for holotype; 2 ♀ ♀, 18-VIII-1995, on Italian ryegrass (*Lolium multiflorum*), other data as for holotype.

Remarks. *Amblyseius* (*P.*) *nemotoi* closely resembles *A. (P.) asetis* (Chant, 1959), *A. (P.) putmani* (Chant, 1959), *A. (P.) tulearensis* Blommers, 1976, and *A. (P.) patellae* (Karg, 1989). However, it differs from them in having the dorsal shield striated along the lateral margins.

Etymology. This species is named in honor of Dr. H. Nemoto, Saitama Prefectural Horticultural Experiment Station, Kuki.

Subgenus *Okiseius* Ehara, 1967

Okiseius Ehara, 1967a: 77. [Type species: *Okiseius subtropicus* Ehara, 1967, by original designation]

Female: Dorsal shield with lateral incisions posterior to R1. Opisthoscutum with R1, Z1, S2, S5, Z4, Z5, and J5 (S4 and J2 absent).

Okiseius was originally proposed as a genus. However, it is treated here as a subgenus of the genus *Amblyseius*.

39. *Amblyseius* (*Okiseius*) *subtropicus* (Ehara, 1967) (Fig. 55)

Okiseius subtropicus Ehara, 1967a: 77, figs 36-39; Ehara and Hamaoka 1980: 6, fig. 12; Wu and Qian 1983: 76, figs 5, 6; Moraes *et al.* 1986: 102; Ehara *et al.* 1994: 136, figs 39-41. *Amblyseius* (*Kampimodromus*) *subtropicus*: Ueckermann and Loots 1985: 195. *Okiseius* (*Okiseius*) *subtropicus*: Kolodochka and Denmark 1996: 235.

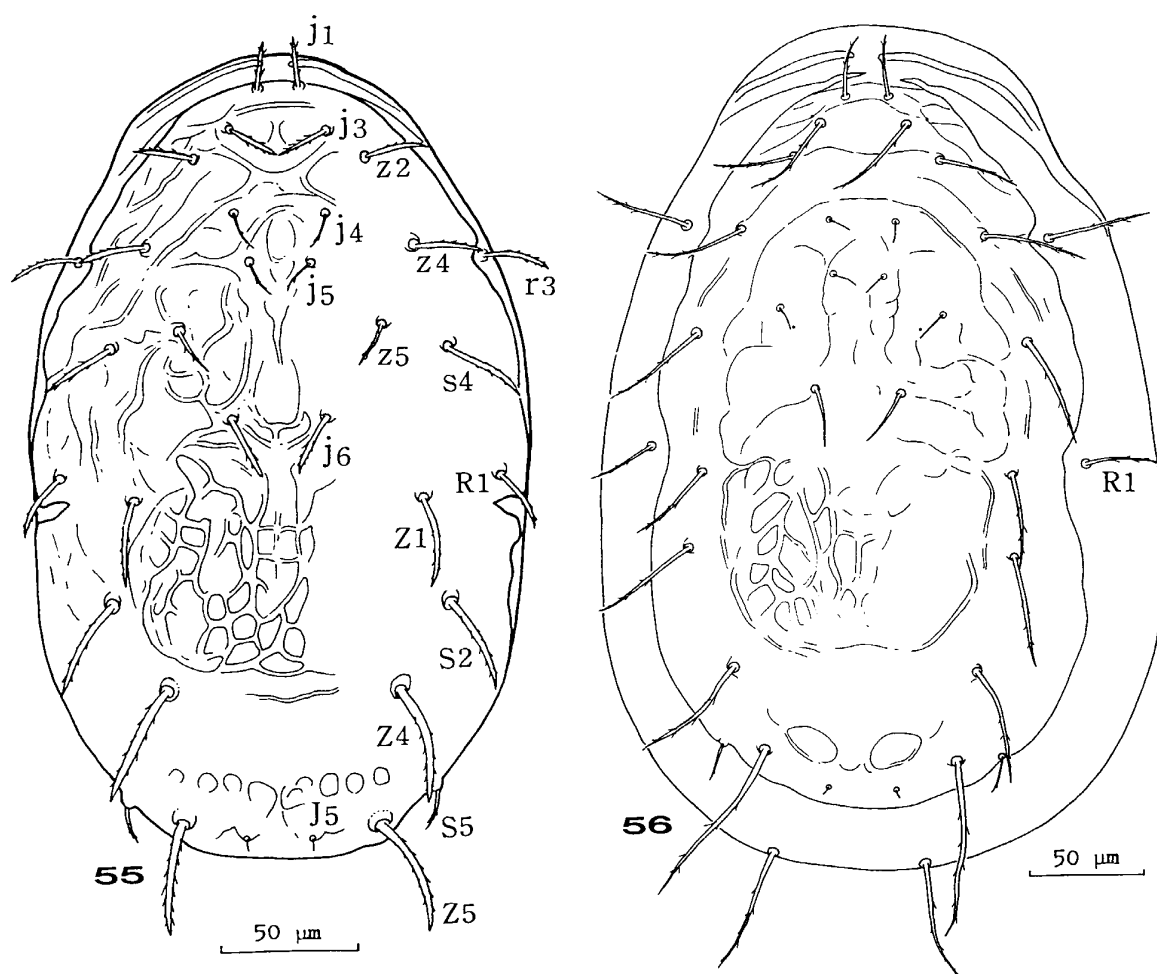
Subgenus *Kampimodromellus* Kolodochka and Denmark, 1996

Okiseius (*Kampimodromellus*) Kolodochka and Denmark, 1996: 241. [Type species: *Amblyseius* (*Kampimodromus*) *maritimus* Ehara, 1967, by original designation]

Female: Dorsal chaetotaxy similar to that of *Okiseius*, except for R1 on interscutal membrane. Dorsal shield without lateral incisions posterior to R1.

40. *Amblyseius* (*Kampimodromellus*) *maritimus* Ehara, 1967 (Fig. 56)

Amblyseius (*Kampimodromus*) *maritimus* Ehara, 1967b: 224, figs 50-57; Ehara 1972:



Figs 55, 56. Dorsum (♀). 55, *Amblyseius* (*Okiseius*) *subtropicus*; 56, *Amblyseius* (*Kampimodromellus*) *maritimus*.

168; Zhu and Chen 1983b: 183, fig. 3; Ehara *et al.* 1994: 135.

Okiseius maritimus: Moraes *et al.* 1986: 102.

Okiseius (*Kampimodromellus*) *maritimus*: Kolodochka and Denmark 1996: 241, figs 54-63.

Genus *Amblyseiulella* Muma, 1961

Amblyseiulella Muma, 1961: 276. [Type species: *Typhlodromus heveae* Oudemans, 1930, by original designation]

Female: Dorsal shield with lateral incisions near s4. Opisthoscutum with Z1, S2, Z4, Z5, and J5 (S4, S5, J2 absent).

41. *Amblyseiulella amanoi* Ehara, 1994 (Figs 20, 33, 46, 57)

Amblyseiulella amanoi Ehara in Ehara *et al.* 1994: 137, figs 42-48.

Genus *Paraphytoseius* Swirski and Shechter, 1961

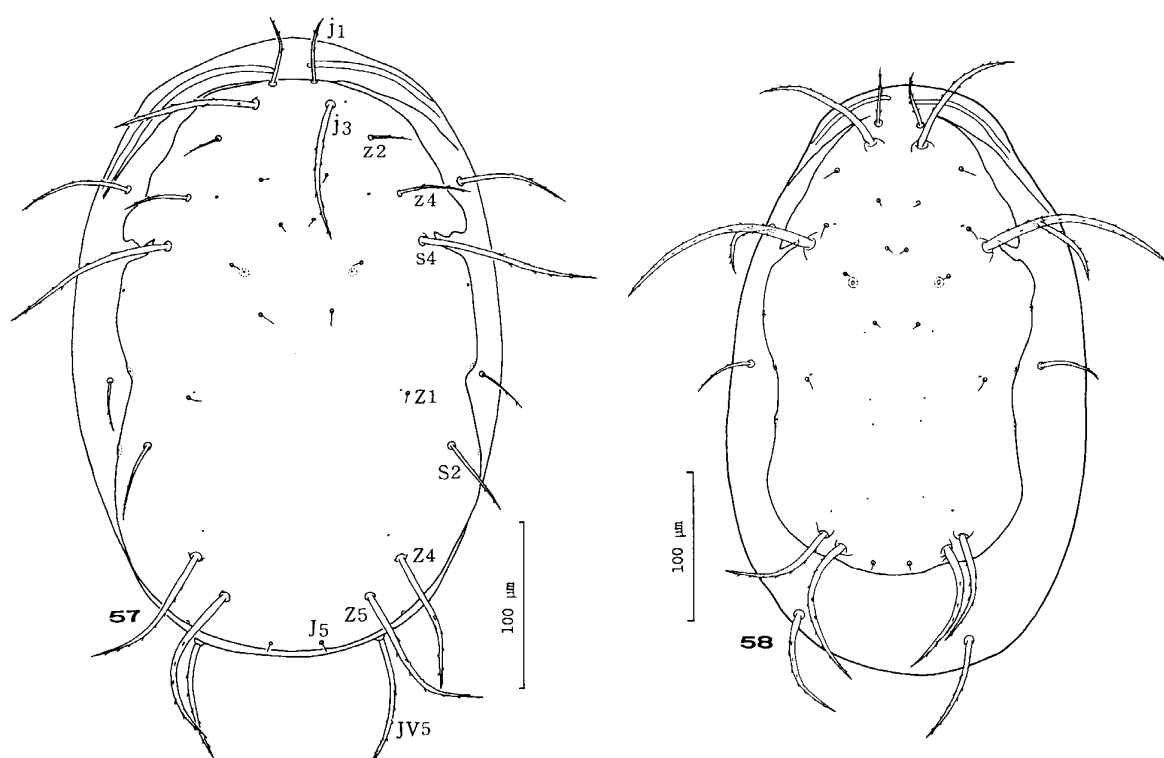
Paraphytoseius Swirski and Shechter, 1961: 113. [Type species: *Paraphytoseius multidentatus* Swirski and Shechter, 1961, by original designation]

Female: Dorsal shield with lateral incisions near s4. Opisthoscutum with Z1, (S4), Z4, Z5, and J5 (S2, S5, J2 absent).

42. *Paraphytoseius multidentatus* Swirski and Shechter, 1961
(Figs 34, 58)

Paraphytoseius multidentatus Swirski and Shechter, 1961: 114, figs 7, 26-28; Ehara 1966: 25; Matthyse and Denmark 1981: 342; Schicha and Corpuz-Raros 1985: 67, figs 1-8; Moraes *et al.* 1986: 104; Ho and Lo 1989: 91, fig. 1; Ehara *et al.* 1994: 139. *Amblyseius (Paraphytoseius) multidentatus*: Ehara 1967a: 77; Ehara and Lee, 1971: 69, figs 26-31; Ehara and Bhandhufalck 1977: 79, figs 131-133. *Amblyseius (Paraphytoseius) urumanus* Ehara, 1967a: 76, figs 31-35.

The following specimens from Kyushu have been examined in this work: One ♀, Kadogawa, Miyazaki Pref., 23-VII-1995 (H. Amano), on *Pueraria lobata*; 8 ♀♀, Tōgo, Kagoshima Pref., 17-X-1996 (S. Mizushima), on *P. lobata*. In Japan this species was previously recorded only from Okinawa Island, and is first reported from



Figs 57, 58. Dorsum (♀). 57, *Amblyseiulella amanoi*; 58, *Paraphytoseius multidentatus*.

Kyushu.

Tribe **Indoseiulini** Ehara and Amano, tribe nov.

[Type genus: *Indoseiulus* Ehara, 1982]

Both sexes of the new tribe are characterized by the peritrematic shields being not fused anteriorly with the dorsal shield.

There is a single genus, *Indoseiulus*, in the tribe Indoseiulini.

Genus ***Indoseiulus*** Ehara, 1982

Indoseiulus Ghai and Menon, 1969: 347 (nec *Indoseiulus* Evans, 1955: 107).

Amblyseius (*Indoseiulus*) Ehara, 1982: 42. [Type species: *Indoseiulus ricini* Ghai and Menon, 1969, by original designation by Ghai and Menon (1969)]

Indoseiulus: Moraes *et al.* 1986: 59; Denmark and Kolodochka 1993: 249; Ehara *et al.* 1994: 139.

Female: Dorsal shield with caudal margin truncate or concave. Peritrematic shields not fused anteriorly with dorsal shield. Opisthoscutum with Z1, S2, Z4, S5, Z5, J2, and J5 (S4 absent). Ventrianal shield poorly sclerotized.

43. ***Indoseiulus liturivorus*** (Ehara, 1982)
(Figs 59-61)

Amblyseius (*Indoseiulus*) *liturivorus* Ehara, 1982: 43, figs 10-18; McMurtry and Moraes 1984: 29; Ehara 1985: 120, figs 25, 26.

Indoseiulus liturivorus: Moraes *et al.*, 1986: 60; Denmark and Kolodochka 1993: 253, figs 13-17; Ehara *et al.* 1994: 139.

Subfamily **Phytoseiinae** Berlese, 1916

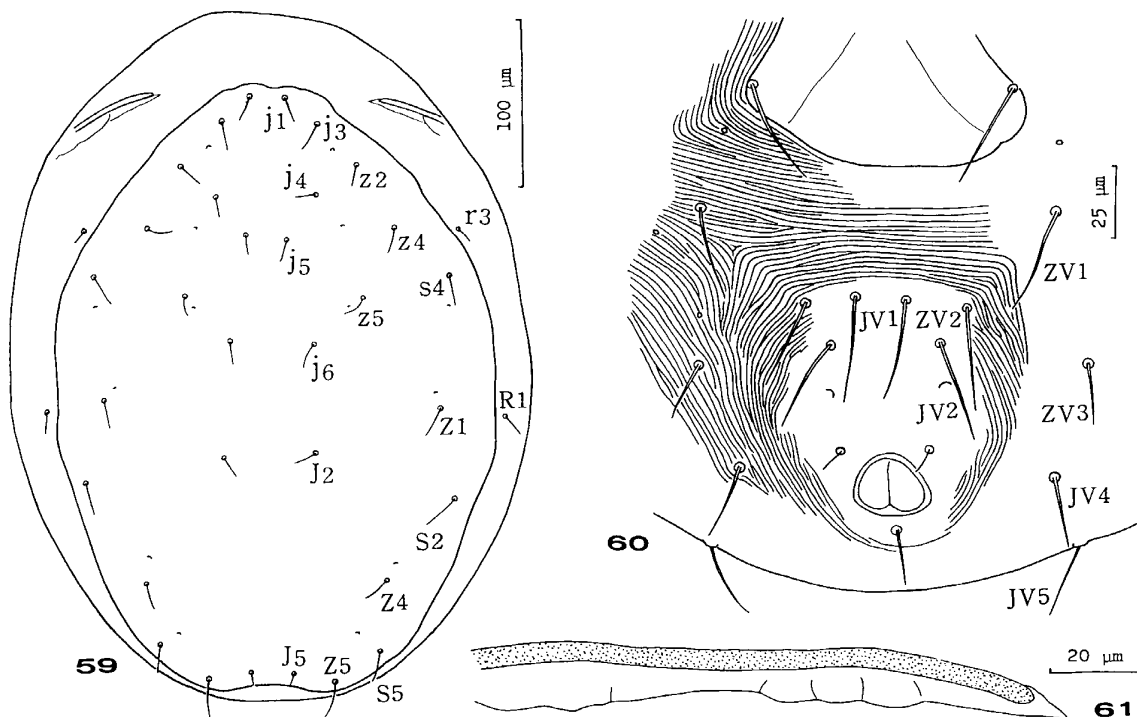
Phytoseiini Berlese, 1916: 33 (in part); Wainstein 1962: 26 [Type genus: *Phytoseius* Ribaga, 1904]

Phytoseiinae Berlese: Vitzthum 1941: 767 (in part).

Genus ***Phytoseius*** Ribaga, 1904

Phytoseius Ribaga, 1904: 177. [Type species: *Gamasus plumifer* Canestrini and Fanzago, 1876, by subsequent designation of Vitzthum (1941)]

Female: Podoscutum with 7 setae along each lateral margin: j3, z2, z3, z4, s4, s6, and r3. Opisthoscutum with only 2 setae on caudolateral area: Z4, Z5. Setae J2 and R1 present or missing. Ventrianal shield much longer than wide, with lateral margins more or less concave.



Figs 59-61. *Indoseiulus liturivorus* (♀). 59, dorsum; 60, posterior ventral surface; 61, anterior part of peritrematic shield.

Key to Subgenera of the Genus *Phytoseius* in Japan

1. Setae J2 and R1 present. *Phytoseius*
 Seta J2 absent, seta R1 present or absent. 2
2. Seta R1 present. *Euryseius*
 Seta R1 absent. *Dubininellus*

Subgenus *Phytoseius* Ribaga, 1904

Phytoseius Ribaga, 1904: 177 (in part). [Type species: *Gamasus plumifer* Canestrini and Fanzago, 1876, by subsequent designation of Vitzthum (1941)]

Phytoseius (*Phytoseius*) Ribaga: Wainstein 1959: 1361; Denmark 1966: 11.

Phytoseius (*Pennaseius*): Pritchard and Baker 1962: 223.

plumifer species group Chant and Yoshida-Shaul, 1992a: 12.

Opisthosoma with setae J2 and R1.

Key to Species of the Subgenus *Phytoseius* in Japan (Females)

1. Dorsal shield with acute incision laterad of seta r3. *hongkongensis*
 Dorsal shield without incisions laterad of seta r3. *tenuiformis*

44. *Phytoseius* (*Phytoseius*) *hongkongensis* Swirski and Shechter, 1961*Phytoseius* (*Phytoseius*) *hongkongensis* Swirski and Shechter, 1961: 99, figs 1-5.*Phytoseius* (*Pennaseius*) *hongkongensis*: Ehara 1966: 25; Ehara and Lee 1971: 70, figs 32-37; Ehara 1972: 169, fig. 81; Ehara *et al.* 1994: 145.45. *Phytoseius* (*Phytoseius*) *tenuiformis* Ehara, 1978

(Figs 62, 66)

Phytoseius (*Pennaseius*) *tenuiformis* Ehara, 1978: 448, figs 8-15; Ehara *et al.* 1994: 145.Subgenus *Euryseius* Wainstein, 1970*Phytoseius* (*Euryseius*) Wainstein, 1970: 1727. [Type species: *Phytoseius purseglovei* DeLeon, 1965, by original designation]*purseglovei* species group Chant and Yoshida-Shaul, 1992a: 12.

Opisthoscutum with seta J2 absent. Seta R1 present.

46. *Phytoseius* (*Euryseius*) *ikeharai* Ehara, 1967

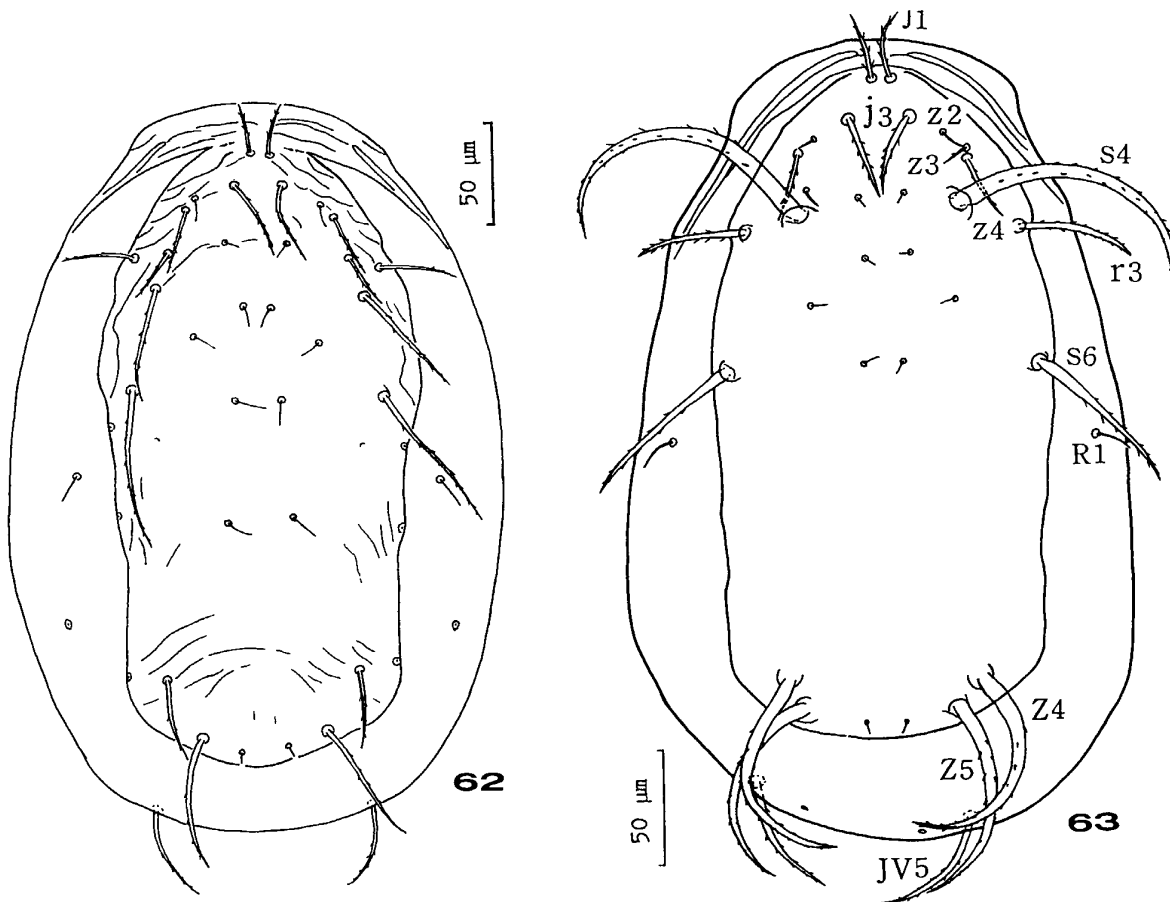
(Fig. 63)

Phytoseius (*Pennaseius*) *ikeharai* Ehara, 1967a: 78, figs 40-43; Ehara *et al.* 1994: 145.*Phytoseius ikeharai*: Chant and Yoshida-Shaul 1992a: 15, figs 17-20.Subgenus *Dubininellus* Wainstein, 1959*Phytoseius* (*Dubininellus*) Wainstein, 1959: 1362. [Type species: *Phytoseius corniger* Wainstein, 1959, by original designation]*Phytoseius* (*Phytoseius*): Pritchard and Baker 1962: 227.*horridus* group Denmark, 1966: 83.*horridus* species group: Chant and McMurtry 1994: 233.

Opisthoscutum with seta J2 absent. Seta R1 absent.

Key to Species of the Subgenus *Dubininellus* in Japan (Females)

1. Ventrianal shield with 1 pair of preanal setae (JV2).2
 Ventrianal shield with 3 pairs of preanal setae (JV1, ZV2, JV2).3
2. Seta s4 much longer than s6. *quercicola*
 Seta s4 about as long as s6. *blakistoni*
3. Leg IV without macrosetae. *intermedius*
 Leg IV with 1 or more macrosetae.4



Figs 62, 63. Dorsum (♀). 62, *Phytoseius* (*Phytoseius*) *tenuiformis*; 63, *Phytoseius* (*Euryseius*) *ikeharai*.

4. Genu IV with a macroseta.5
Genu IV without macrosetae.8
5. Setae s4, s6, Z4, Z5, and r3 more or less divided longitudinally.*crinitus*
Setae s4, s6, Z4, Z5, and r3 not divided longitudinally.6
6. Macroseta on tibia IV subequal in length to that on basitarsus IV.*kazusanus*
Macroseta on tibia IV much longer than that on basitarsus IV.7
7. Seta j3 about as long as r3.*kishii*
Seta j3 much shorter than r3.*campestris*
8. Macroseta on tibia IV at least 2.5 times as long as that on basitarsus IV; genu IV without blunt setae.*nipponicus*
Macroseta on tibia IV less than twice as long as that on basitarsus IV; genu IV with 2 blunt setae.*capitatus*

47. *Phytoseius* (*Dubininellus*) *quercicola* Ehara, 1994

Phytoseius (*Phytoseius*) *quercicola* Ehara in Ehara et al. 1994: 140, figs 50-58.

48. ***Phytoseius* (*Dubininellus*) *blakistoni*** Ehara, 1966
(Figs 2, 13, 21, 67)

Phytoseius (*Phytoseius*) *blakistoni* Ehara, 1966: 14, figs 20-26; Ehara 1972:169, fig. 82; Ehara *et al.* 1994: 142.

49. ***Phytoseius* (*Dubininellus*) *intermedius*** Evans and Macfarlane, 1961

Phytoseius (*Dubininellus*) *intermedius* Evans and Macfarlane, 1961: 587, figs 1-3.
Phytoseius (*Phytoseius*) *intermedius*: Ehara 1972: 170, figs 122-125; Ehara *et al.* 1994: 142.

50. ***Phytoseius* (*Dubininellus*) *crinitus*** Swirski and Shechter, 1961

Phytoseius (*Dubininellus*) *crinitus* Swirski and Shechter, 1961: 102, figs 6, 8-10.
Phytoseius (*Phytoseius*) *crinitus*: Ehara 1966: 26; Ehara 1967a: 79, figs 44-47; Ehara and Lee 1971: 71, figs 38-41; Ehara *et al.* 1994: 142.

51. ***Phytoseius* (*Dubininellus*) *kazusanus*** Ehara, 1994

Phytoseius (*Phytoseius*) *kazusanus* Ehara in Ehara *et al.* 1994: 142, figs 59-66.

52. ***Phytoseius* (*Dubininellus*) *kishii*** Ehara, 1967

Phytoseius (*Phytoseius*) *kishii* Ehara, 1967b: 228, figs 64-67; Ehara *et al.* 1994: 144.

53. ***Phytoseius* (*Dubininellus*) *campestris*** Ehara, 1967

Phytoseius (*Phytoseius*) *campestris* Ehara, 1967b: 229, figs 68-71; Ehara *et al.* 1994: 144.

54. ***Phytoseius* (*Dubininellus*) *nipponicus*** Ehara, 1962

Phytoseius (*Dubininellus*) *nipponicus* Ehara, 1962: 55, figs 7-11; Denmark 1966: 90, fig. 38.
Phytoseius (*Phytoseius*) *nipponicus*: Ehara 1966: 26; Ehara 1967b: 227, figs 58-63; Ehara *et al.* 1994: 144.
Phytoseius nipponicus: Ehara and Amano 1993: 4, fig. 2.

55. ***Phytoseius* (*Dubininellus*) *capitatus*** Ehara, 1966

Phytoseius (*Phytoseius*) *capitatus* Ehara, 1966: 15, figs 27-32; Ehara 1972: 170; Ehara

et al. 1994: 145.

Subfamily **Typhlodrominae** Wainstein, 1962

Typhlodromini Wainstein, 1962: 26 (in part). [Type genus: *Typhlodromus* Scheuten, 1857]

Typhlodrominae: Chant and McMurtry 1994: 235.

Key to Tribes of the Subfamily Typhlodrominae in Japan (Females) (Chant and McMurtry 1994, modified)

1. Podoscutum with 5 setae along each lateral margin: j3, z2, z3, z4, s4 (s6 absent).
.....Chanteiini
- Podoscutum with 6 setae along each lateral margin (s6 present).2
2. Seta z6 present between s6 and j6.Paraseiulini
- Seta z6 absent.Typhlodromini

Tribe **Chanteiini** Chant and McMurtry, 1994

Chanteiini Chant and McMurtry, 1994: 237. [Type genus: *Chanteius* Wainstein, 1962]

Genus **Chanteius** Wainstein, 1962

Chanteius (*Chanteius*) Wainstein, 1962b: 19. [Type species: *Typhlodromus contiguus* Chant, 1959, by original designation]

Chanteius: Chant and Yoshida-Shaul 1987b: 2574.

Podoscutum with seta z3, without s6; opisthoscutum with Z1 and S5.

56. **Chanteius contiguus** (Chant, 1959) (Fig. 64)

Typhlodromus (*Typhlodromus*) *contiguus* Chant, 1959a: 29, figs 1-6.

Typhloseiopsis contiguus: Muma 1961: 294.

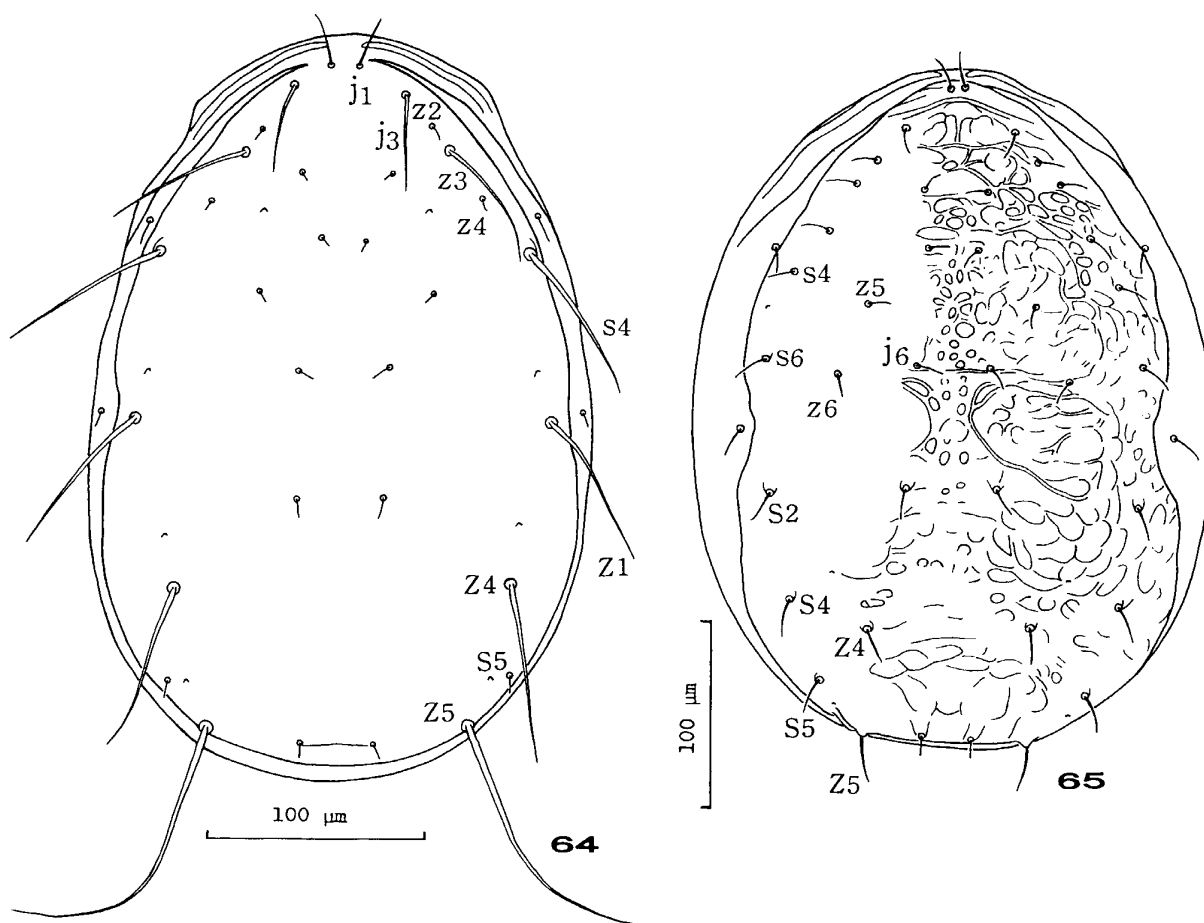
Typhlodromus (*Typhloseiopsis*) *contiguus*: Pritchard and Baker 1962: 222; Ehara 1966: 20; Ehara 1967a: 71, figs 12-16; Ehara 1977: 31.

Diadromus contiguus: Chant and Yoshida-Shaul 1986b: 2030, figs 12-16.

Chanteius contiguus: Ehara *et al.* 1994: 155; Chant and McMurtry 1994: 239, figs 45-49.

Tribe **Paraseiulini** Wainstein, 1976

Paraseiulini Wainstein, 1976: 697. [Type genus: *Paraseiulus* Muma, 1961]



Figs 64, 65. Dorsum (♀). 64, *Chanteius contiguus*; 65, *Kuzinellus yokogawae*.

Key to Genera of the Tribe Paraseiulini in Japan (Females)

1. JV2 and JV3 absent. Ventrianal shield with 2 pairs of preanal setae: JV1, ZV2. ... *Paraseiulus*
- JV2 and JV3 present. Ventrianal shield with 4 pairs of preanal setae: JV1, ZV2, JV2, JV3. ... *Kuzinellus*

Genus *Paraseiulus* Muma, 1961

Paraseiulus Muma, 1961: 299 (in part). [Type species: *Seiulus soleiger* Ribaga, 1904, by original designation]

Typhlodromus (*Paraseiulus*): van der Merwe, 1968: 60 (in part).

Female: Podoscutum with seta z6 between j6 and s6. Opisthoscutum with Z1 absent, Z3 rarely present. Ventrianal shield with 2 pairs of preanal setae: JV1 and ZV2. Setae JV2 and JV3 absent.

57. *Paraseiulus soleiger* (Ribaga, 1904)
(Figs 22, 39)

Seiulus soleiger Ribaga, 1904: 176.

Typhlodromus soleiger: Nesbitt 1951: 39, pl. XII, figs 30, 32; Chant *et al.* 1974: 1283, figs 62-65; Chant and Yoshida-Shaul 1982: 3027, figs 13-16.

Paraseiulus soleiger: Muma 1961: 300; Karg 1971: 216, figs 233a, 234a, 235a; Chant and McMurtry 1994: 243, figs 75-79.

Typhlodromus (Paraseiulus) soleiger: van der Merwe 1968: 60; Ehara 1985: 116, figs 7-12; Ehara *et al.* 1994: 155.

Genus *Kuzinellus* Wainstein, 1976

Kuzinellus Wainstein, 1976: 699. [Type species: *Paraseiulus kuzini* Wainstein, 1962, by original designation]

Female: Podoscutum with seta z6 between setae s6 and j6; opisthoscutum without seta Z1. Ventrianal shield with 4 pairs of preanal setae: JV1, ZV2, JV2, JV3.

58. *Kuzinellus yokogawae* (Ehara and Hamaoka, 1980), comb. nov.
(Figs 14, 65)

Typhlodromus (Paraseiulus) yokogawae Ehara and Hamaoka, 1980: 3, figs 1-7; Ehara *et al.* 1994: 155.

Typhlodromus yokogawae: Chant and Yoshida-Shaul 1986a: 459, figs 42-45.

Paraseiulus yokogawae: Moraes *et al.* 1986: 209.

Tribe *Typhlodromini* Wainstein, 1962

Typhlodromini Wainstein, 1962: 26. [Type genus: *Typhlodromus* Scheuten, 1857]

Genus *Typhlodromus* Scheuten, 1857

Typhlodromus Scheuten, 1857: 111. [Type species: *Typhlodromus pyri* Scheuten, 1857, by subsequent designation of Oudemans (1929)]

Female: Podoscutum with 6 setae along each lateral margin: j3, z2, z3, z4, s4, s6. Seta z6 absent. Seta S5 present or absent.

Key to Subgenera of the Genus *Typhlodromus* in Japan (Females)

1. Opisthoscutum with 4 setae along each lateral margin: S2, S4, S5, Z5. *Anthoseius*
Opisthoscutum with 3 setae along each lateral margin: S2, S4, Z5 (S5 absent).

..... *Typhlodromus*

Subgenus *Anthoseius* DeLeon, 1959

Anthoseius DeLeon, 1959: 258. [Type species: *Anthoseius hebetis* DeLeon, 1959, by original designation]

Amblydromella Muma, 1961: 294.

Female: Opisthoscutum with 4 setae along each lateral margin: S2, S4, S5, and Z5. Sternal shield with 2 or 3 pairs of setae: ST1, ST2, (ST3). Ventrianal shield with 3 or 4 pairs of setae: JV1, ZV2, JV2, (JV3).

Key to Species Groups of the Subgenus *Anthoseius* in Japan (Females)

1. Ventrianal shield with 3 pairs of preanal setae: JV1, ZV2, JV2 (JV3 absent). ...
..... *singularis* species group
- Ventrianal shield with 4 pairs of preanal setae: JV1, ZV2, JV2, JV3.2
2. Sternal shield with 2 pairs of setae: ST1, ST2. *rhenanus* species group
- Sternal shield with 3 pairs of setae: ST1, ST2, ST3. *vulgaris* species group

***singularis* species group**

Typhlodromus (Oudemanus) Denmark, 1992: 34.

singularis species group Chant and McMurtry, 1994: 252.

[Exemplar species: *Typhlodromus singularis* Chant, 1957]

Female: Sternal shield with 2 pairs of setae: ST1, ST2. Ventrianal shield with 3 pairs of setae: JV1, ZV2, JV2. Seta JV3 absent.

Key to Species of the *singularis* Species Group in Japan (Females)

1. Seta Z4 longer than distance between its base and that of S5. *bambusae*
- Seta Z4 shorter than distance between its base and that of S5.2
2. Seta Z5 longer than distance between its base and that of S5. *viktorovi*
- Seta Z5 shorter than distance between its base and that of S5. *ternatus*

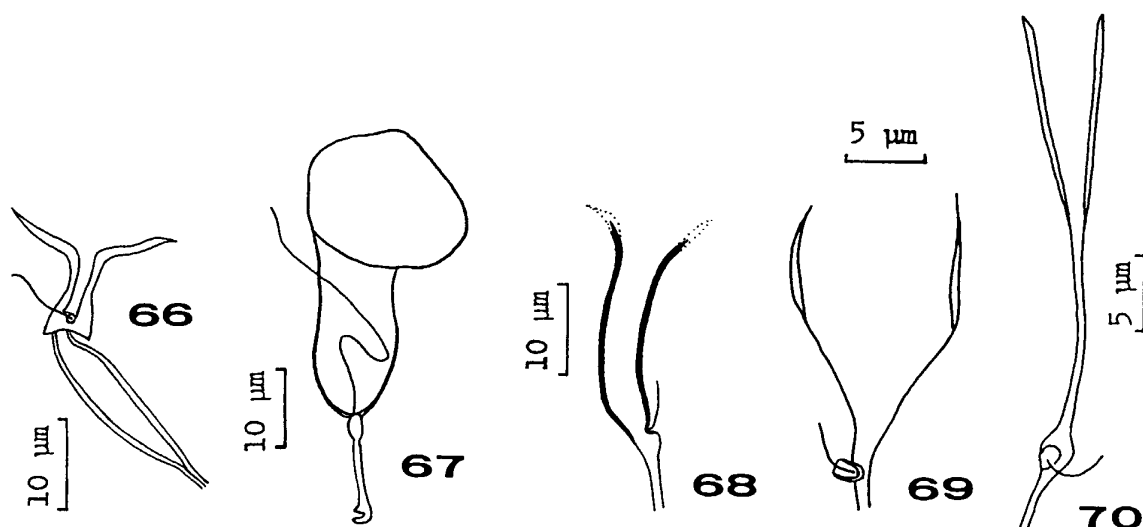
59. *Typhlodromus (Anthoseius) bambusae* Ehara, 1964
(Figs 3, 68)

Typhlodromus (Neoseiulus) bambusae Ehara, 1964: 379, figs 1-4.

Typhlodromus (Anthoseius) takahashii Ehara, 1978: 446, figs 1-7.

Typhlodromus (Anthoseius) bambusae: Ehara 1981: 237; Ehara *et al.* 1994: 147.

Amblydromella bambusae: Moraes *et al.* 1986: 156.



Figs 66-70. Spermathecae. 66, *Phytoseius* (*Phytoseius*) *tenuiformis*; 67, *P.* (*Dubininellus*) *blakistoni*; 68, *Typhlodromus* (*Anthoseius*) *bambusae*; 69, *T.* (*A.*) *viktorovi*; 70, *T.* (*A.*) *vulgaris*.

60. *Typhlodromus* (*Anthoseius*) *viktorovi* (Wainstein, 1975)
(Figs 40, 69)

Anthoseius (*Anthoseius*) *viktorovi* Wainstein, 1975: 915, fig. 2.

Amblydromella viktorovi: Moraes *et al.* 1986: 178.

Typhlodromus (*Anthoseius*) *viktorovi*: Ehara *et al.* 1994: 147.

61. *Typhlodromus* (*Anthoseius*) *ternatus* Ehara, 1972

Typhlodromus (*Anthoseius*) *ternatus* Ehara, 1972: 145, figs 31-35; Ehara *et al.* 1994: 149.

Amblydromella ternata: Moraes *et al.* 1986: 176.

***rhenanus* species group**

Typhlodromus rhenanus group Chant, 1959b: 62 (in part).

rhenanus species group: Chant and McMurtry 1994: 254.

[Exemplar species: *Seiulus rhenanus* Oudemans, 1905]

Female: Sternal shield with 2 pairs of setae: ST1, ST2. Ventrianal shield with 4 pairs of setae: JV1, ZV2, JV2, JV3.

Key to Species of the *rhenanus* Species Group in Japan (Females)

1. Peritreme reaching anteriorly in front of seta j1.2
 Peritreme not reaching anteriorly in front of seta j1.4
2. Ventrianal shield with pores caudal to posteromedian pair of preanal setae (JV2).*borealis*
 Ventrianal shield with pores both between and behind posteromedian pair of preanal setae (JV2).3
3. Leg IV with 3 macrosetae, on genu, tibia, and basitarsus.*ryukyuensis*
 Leg IV with 1 macroseta, on basitarsus.*yasumatsui*
4. Leg IV with 3 macrosetae, on genu, tibia, and basitarsus.*shibai*
 Leg IV with 1 macroseta, on basitarsus.*kadonoi*

62. *Typhlodromus* (*Anthoseius*) *borealis* Ehara, 1967

Typhlodromus (*Anthoseius*) *borealis* Ehara, 1967b: 213, figs 1-7; Ehara *et al.* 1994: 149.
Amblydromella borealis: Moraes *et al.* 1986: 156.

63. *Typhlodromus* (*Anthoseius*) *ryukyuensis* Ehara, 1967

Typhlodromus (*Anthoseius*) *ryukyuensis* Ehara, 1967a: 69, figs 7-11; Ehara 1970: 55;
 Ehara *et al.* 1994: 149.
Amblydromella ryukyuensis: Moraes *et al.* 1986: 174.

64. *Typhlodromus* (*Anthoseius*) *yasumatsui* Ehara, 1966

Typhlodromus (*Neoseiulus*) *yasumatsui* Ehara, 1966: 11, figs 7-4.
Typhlodromus (*Anthoseius*) *yasumatsui*: Ehara 1975: 26; Ehara *et al.* 1994: 149.
Amblydromella yasumatsui: Moraes *et al.* 1986: 179.

65. *Typhlodromus* (*Anthoseius*) *shibai* Ehara, 1981

Typhlodromus (*Anthoseius*) *shibai* Ehara, 1981: 235, figs 1-9; Ehara *et al.* 1994: 149.
Amblydromella shibai: Moraes *et al.* 1986: 175.

66. *Typhlodromus* (*Anthoseius*) *kadonoi* Ehara, 1994

Typhlodromus (*Anthoseius*) *kadonoi* Ehara *in* Ehara *et al.* 1994: 149, figs 75-82.

***vulgaris* species group**

[Exemplar species: *Typhlodromus vulgaris* Ehara, 1959]

Female: Sternal shield with 3 pairs of setae: ST1, ST2, ST3. Ventrianal shield with 4 pairs of setae: JV1, ZV2, JV2, JV3.

Key to Species of the *vulgaris* Species Group in Japan (Females)

1. Seta Z5 capitate.2
Seta Z5 acuminate.3
2. Leg IV with 3 macrosetae, on genu, tibia, and basitarsus.*serrulatus*
Leg IV with 1 macroseta, on basitarsus.*higoensis*
3. Seta Z4 noticeably longer than S4.4
Seta Z4 about as long as S4.5
4. Leg IV with 3 capitate macrosetae, on genu, tibia, and basitarsus.*vulgaris*
Leg IV with 1 capitate macroseta, on basitarsus.*yamashitai*
5. Ventrianal shield with pores caudal to posteromedian pair of preanal setae (JV2).*hirashimai*
Ventrianal shield with pores both between and behind posteromedian pair of preanal setae (JV2).6
6. Leg IV with 1 macroseta, on basitarsus.*kiso*
Leg IV with 3 macrosetae, on genu, tibia, and basitarsus.7
7. Macroseta on tibia IV approximately twice as long as that on genu IV.
.....*insularis*
Macroseta on tibia IV about as long as that on genu IV.8
8. Seta Z5 about twice the length of Z4.*silvanus*
Seta Z5 less than twice the length of Z4.*miyarai*

67. *Typhlodromus* (*Anthoseius*) *serrulatus* Ehara, 1972
(Figs 4, 15)

Typhlodromus (*Anthoseius*) *serrulatus* Ehara, 1972: 142, figs 19-24; Wu 1985: 84, figs 8, 9; Ryu and Lee 1992: 31, figs 40-49; Ehara *et al.* 1994: 151.

Amblydromella serrulata: Moraes *et al.* 1986: 179.

68. *Typhlodromus* (*Anthoseius*) *higoensis* Ehara, 1985

Typhlodromus (*Anthoseius*) *higoensis* Ehara, 1985: 115, figs 1-6; Ehara *et al.* 1994: 151.

Amblydromella higoensis: Moraes *et al.* 1986: 163.

69. *Typhlodromus* (*Anthoseius*) *vulgaris* Ehara, 1959
(Figs 41, 70)

Typhlodromus vulgaris Ehara, 1959 (July): 286, figs 1-5; Ehara 1961: 95, figs 1, 2; Ehara 1962: 53; Chen *et al.* 1984: 314, fig. 14(10); Ehara and Amano 1993: 2, fig. 1.

Typhlodromus (*Neoseiulus*) *vulgaris*: Ehara 1964: 381; Ehara 1966: 18.

Typhlodromus (*Anthoseius*) *vulgaris*: Ehara 1975: 26; Ehara *et al.* 1994: 151, figs 83-86.

Amblydromella vulgaris: Moraes *et al.* 1986: 178.

Typhlodromus (*Typhlodromus*) *juniperus* Chant, 1959b (December): 61, figs 76, 77.

70. *Typhlodromus* (*Anthoseius*) *yamashitai* Ehara, 1972

Typhlodromus (*Anthoseius*) *yamashitai* Ehara, 1972: 143, figs 25-30; Ehara *et al.* 1994: 152.

Amblydromella yamashitai: Moraes *et al.* 1986: 178.

71. *Typhlodromus* (*Anthoseius*) *hirashimai* Ehara, 1972

Typhlodromus (*Anthoseius*) *hirashimai* Ehara, 1972: 152, figs 11-18; Ehara *et al.* 1994: 152.

Amblydromella hirashimai: Moraes *et al.* 1986: 163.

72. *Typhlodromus* (*Anthoseius*) *kiso* Ehara, 1972

Typhlodromus (*Anthoseius*) *kiso* Ehara, 1972: 138, figs 1-10; Ehara 1993: 192, fig. 93 (1, 2-right); Ehara *et al.* 1994: 153.

Amblydromella kiso: Moraes *et al.* 1986: 166.

73. *Typhlodromus* (*Anthoseius*) *insularis* Ehara, 1966

Typhlodromus (*Neoseiulus*) *insularis* Ehara, 1966: 10, figs 1-6.

Typhlodromus (*Anthoseius*) *insularis*: Ehara 1967b: 212; Ehara 1972: 138, figs 75, 76; Ehara and Hamaoka 1980: 5; Ehara *et al.* 1994: 153.

Amblydromella insularis: Moraes *et al.* 1986: 164.

74. *Typhlodromus* (*Anthoseius*) *silvanus* Ehara and Kishimoto, 1994

Typhlodromus (*Anthoseius*) *silvanus* Ehara and Kishimoto *in* Ehara *et al.* 1994: 153, figs 87-92.

75. *Typhlodromus* (*Anthoseius*) *miyarai* Ehara, 1967

Typhlodromus (*Anthoseius*) *miyarai* Ehara, 1967a: 68, figs 1-6; Ehara *et al.* 1994: 154.

Amblydromella miyarai: Moraes *et al.* 1986: 167.

Subgenus *Typhlodromus* Scheuten, 1857

Typhlodromus Scheuten, 1857: 111. [Type species: *Typhlodromus pyri* Scheuten, 1857, by subsequent designation of Oudemans (1929)]

Female: Opisthoscutum with 3 setae along each lateral margin: S2, S4, Z5. Sternal shield with 2 or 3 pairs of setae: ST1, ST2, (ST3). Ventrianal shield with 3 or 4 pairs of setae: JV1, ZV2, JV2, (JV3).

The two Japanese species now included in this subgenus should in principle be assigned to different species groups, but the subgenus is not subdivided into species groups in the present paper.

Key to Species of the Subgenus *Typhlodromus* in Japan (Females)

1. Dorsal idiosomal setae capitate; ventrianal shield with 4 pairs of preanal setae.
..... *pseudopyri*
- Dorsal idiosomal setae attenuate; ventrianal shield with 3 pairs of preanal setae.
..... *armiger*

76. *Typhlodromus* (*Typhlodromus*) *pseudopyri* Ehara and Amano, sp. nov.

(Japanese name: Nise-pairai-kaburidani)

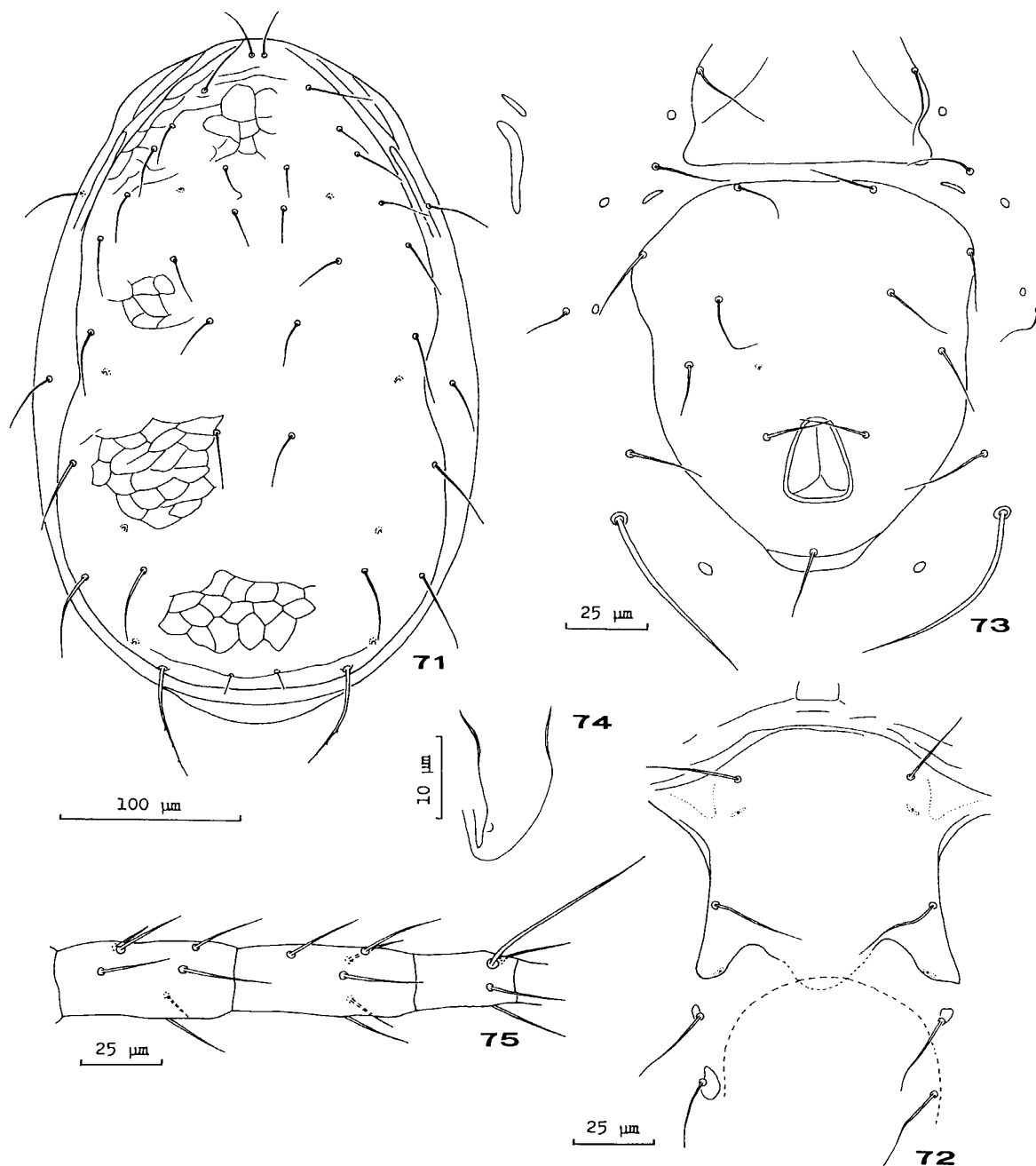
(Figs 71-75)

Female. Dorsal shield imbricate, with 4 pairs of conspicuous solenostomes. Setae on dorsal shield: Z5 the longest, sparsely serrate, much shorter than distance Z5-Z5; remaining setae smooth, Z4 shorter than S4, longer than distance S4-Z4. Setae r3 and R1 smooth. Peritreme extending anteriorly to level between z2 and Z3; posterior extension of peritrematic shield narrow, truncate. Sternal shield with 2 pairs of setae and convex posterior margin; seta ST3 on very small platelet; metasternal platelet, bearing ST4, larger, longer than wide. Ventrianal shield longer than wide, wider than genital shield, with lateral margins slightly concave; 4 pairs of preanal setae; pair of pores suspected to be nearly in line with JV3 setae (one of these pores missing on holotype). Two pairs of slender metapodal platelets. Cervix of spermatheca sack-like, more strongly sclerotized distally; proximal part with C-shaped atrium, gradually narrowing towards major duct. Dentition of chelicera not observable because of angle. Chaetotaxic formula: genu II, 2-2/0, 2/0-1; genu III, 1-2/1, 2/0-1. Basitarsus IV with macroseta. Measurements: length of idiosoma 401, width of idiosoma 241, length of dorsal shield 384, width of dorsal shield 211; lengths of setae: j1 29.4, j3 38.5, j4 20.7, j5 25.9, j6 27.8, J2 35.7, J5 11.1, z2 26.5, z3 32.4, z4 32.2, z5 26.9, Z4 45.0, Z5 61.2, s4 38.3, s6 39.1, S2 45.6, S4 48.2, r3 34.4, R1 35.9, JV5 65.3, macroseta on basitarsus IV 62.1.

Male. Not known.

Holotype. Female, Fujimoto, Tsukuba, Ibaraki Pref., 11-V-1996 (H. Kishimoto), on pear.

Remarks. *Typhlodromus* (*T.*) *pseudopyri* is closely related to *T.* (*T.*) *quercicolus* Denmark, 1992 but is readily distinguished from the latter by having a median posterior lobe on the sternal shield, as opposed to a nearly straight posterior margin as in *T.* (*T.*) *quercicolus*. In addition, this new species somewhat resembles *T.* (*T.*) *pyri* Scheuten, 1857, but differs from it in having four pairs of conspicuous solenostomes on the dorsal shield and in having setae Z4 shorter than S4; *T.* (*T.*) *pyri* has three pairs of conspicuous solenostomes, and setae Z4 longer than S4 (Chant and Yoshida-Shaul 1987a; Denmark 1992).



Figs 71-75. *Typhlodromus* (*Typhlodromus*) *pseudopyri* sp. nov. (♀, holotype). 71, dorsum; 72, sternal shield; 73, posterior ventral surface; 74, spermatheca; 75, leg IV.

Etymology. Referring to the morphological similarities between the new species and *T. (T.) pyri*.

77. *Typhlodromus* (*Typhlodromus*) *armiger* Ehara and Amano, sp. nov.
(Japanese name: Tamage-kaburidani)
(Figs 76-80)

Female. Dorsal shield reticulate, with 4 pairs of distinct solenostomes. Dorsal

idiosomal setae, including r3 and R1, serrate, capitate, hyaline-tipped; Z5 the longest, slightly longer than Z4, shorter than distance between bases of Z5; S4 longer than distance between bases of S4 and Z4. Peritreme reaching anteriorly to level between j3 and z2; posterior extension of peritrematic shield truncate. Sternal shield with 2 pairs of setae and markedly lobate posterior margin; seta ST3 on ill-defined platelet; metasternal seta (ST4) on variable platelet. Ventrianal shield much longer than wide, narrower than genital shield, with concave lateral margins; 3 pairs of preanal setae (JV3 absent); no pores. Seta JV5 similar to dorsal idiosomal setae. Two pairs of slender metapodal platelets. Cervix of spermatheca sack-like, more strongly sclerotized distally. Chelicera in poor condition, fixed digit with 2-3 adjacent teeth distally, with no teeth proximal to pilus dentilis, dentition near pilus dentilis not discernible because of angle; movable digit unidentate. Chaetotaxic formula: genu II, 2-2/0, 2/0-1; genu III, 1-2/1, 2/0-1. Leg IV with 3 capitate, hyaline-tipped macrosetae, on genu, tibia, and basitarsus (on holotype, macroseta of tibia IV replaced by normal attenuate seta). Measurements: length of idiosoma 417 (387), width of idiosoma 324 (304), length of dorsal shield 377 (356), width of dorsal shield 238 (221); lengths of setae: j1 30.0 (28.0), j3 39.7 (38.5), j4 29.0 (28.0), j5 30.6 (29.4), j6 35.9 (35.2), J2 40.3 (40.3), J5 8.1 (7.1), z2 24.9 (23.5), z3 39.5 (37.1), z4 41.5 (40.7), z5 28.3 (27.1), Z4 53.8 (52.5), Z5 63.9 (63.2), s4 46.1 (44.4), s6 48.6 (47.2), S2 53.0 (50.4), S4 56.7 (53.5), r3 38.6 (37.9), R1 41.6 (37.9), JV5 56.5 (57.1), macrosetae on leg IV: genu 24.5 (24.0), tibia 28.0(-), basitarsus 45.6 (44.8).

Male. Not known.

Type series. Holotype: ♀, Kuki, Saitama Pref., 14-VII-1995 (A. Koike), on Italian ryegrass (*Lolium multiflorum*). Paratype: 1 ♀, 8-VI-1995, other data as for holotype.

Remarks. This new species resembles *T. (T.) longipalpus* Swirski and Ragusa, 1976 and *T. (T.) leptodactylus* Wainstein, 1961 in having three pairs of preanal setae, but differs from both in that the dorsal idiosomal setae are much longer, capitate and hyaline-tipped, and the sternal shield is markedly lobate posteriorly.

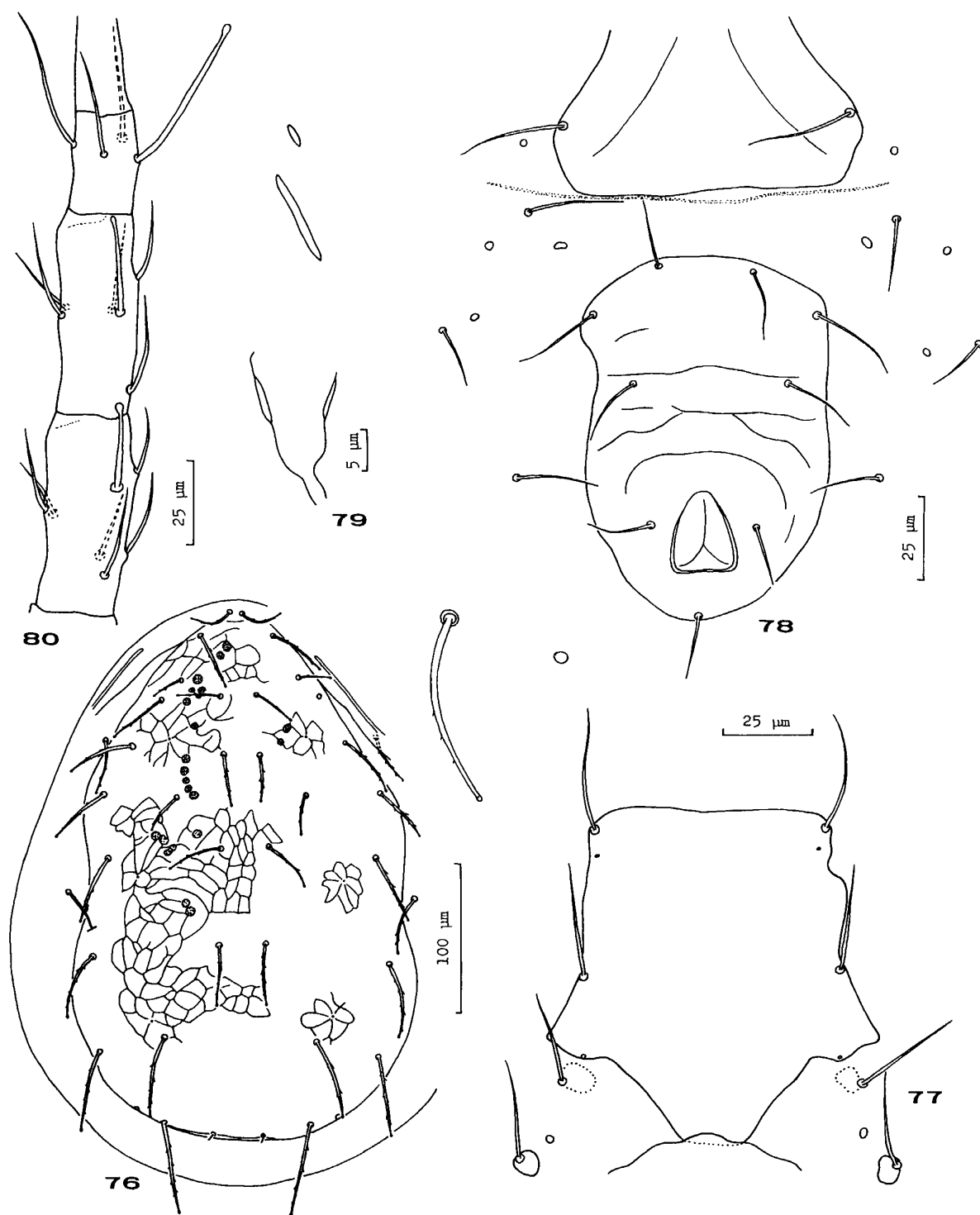
Etymology. Referring to the capitate dorsal setae on idiosoma.

Notes on Biology

Distribution and determining factors

The species diversity of Japanese phytoseiid mites shows a remarkable variety of biological characteristics. This country extending north and south provides an array of host plant flora as well as phytoseiid niches. Many phytoseiids in Japan are of temperate origin, but some are those adapted to either colder or warmer climates. Species with their principal distribution in colder climates include *Amblyseius ezoensis*, *A. morii*, *A. firmus*, *A. finlandicus*, *Typhlodromus bambusae*, and *T. viktorovi*, and those in warmer regions include *A. ovalis*, *A. subtropicus*, *Paraphytoseius multidentatus*, *Phytoseius hongkongensis*, *P. ikeharai*, *P. crinitus*, *Chanteius contiguus*, *T. ryukyuensis*, and *T. miyarai*. Unfortunately, details of the biology of these nominated species are unknown, with the exception of *T. bambusae* (Saito 1986).

As in the case of other countries, much of the biological data on Japanese phytoseiids come from species that have a close association with the agricultural environment. In spite of this bias, one characteristic of their fauna is a high proportion of species native to Japan and surrounding countries. Among the 77 nominal



Figs 76-80. *Typhlodromus (Typhlodromus) armiger* sp. nov. (♀). 76, dorsum; 77, sternal shield; 78, posterior ventral surface; 79, spermatheca; 80, leg IV. [71, 73, 74, holotype; 72, 75, paratype]

species in this paper, 60 were described by the senior author, and this ratio suggests that an isolated evolutionary process occurred in Japan which resulted in the formation of a rather unique phytoseiid fauna.

To explain the species diversity of Japanese phytoseiids, several factors that may have limited their distribution and establishment can be mentioned. First, geographical factors determine the success of survival of species. Species of tropical or subtropical origin, including those in the genus *Phytoseiulus* Evans, often experience difficulty in establishing a good population. Furthermore, a group of species belonging to the genera *Galendromus* Muma and *Metaseiulus* Muma, which are among the major taxa in the subfamily Typhlodrominae in the New World (Chant and McMurtry 1994), have never been collected in Japan. Second, food habits and host plant suitability influence their establishment. A triangular relationship in the plant-prey-phytoseiid system was discussed by Amano (1996). Factors include: the capability of each species to capture foods of various types (spider mites, eriophyoid mites, small insects, pollen, plant materials, etc.); and plant structure and volatile chemicals of plants, which may play a significant role in attracting phytoseiids as well as phytophagous prey. There is economic importance in the ability of phytoseiid mites to capture spider mites, especially the heavily webbing *Tetranychus* spp. Without this ability, the use of phytoseiids as biological control agents would be rather limited in agroecosystems. The third and final factor is man-made. Survival of phytoseiids is sometimes determined by agricultural and other activities of man. Cultivated crops are often key hosts for prey as well as phytoseiid mites, and the recent increase of greenhouse facilities provides a new habitat for these organisms. The temporary establishment of *Phytoseiulus persimilis* Athias-Henriot is a good example of the latter case in Japan. On the other hand, a pesticide application in the field may threaten their survival and only species with a high tolerance to chemicals are able to stay. Along this line, *A. californicus* and pesticide-tolerant strains of *A. womersleyi* are reported to survive in sprayed agricultural fields (e.g., Hamamura 1986; Monetti and Fernandez 1995).

Phytoseiid taxa and their biology

Few studies have been conducted on the relationship between phytoseiid taxa and their biological characteristics (life types) in Japan. Ehara (1977) listed 58 species of native phytoseiids with their associated vegetation types (10 categories), based on his collection records and other information. Two general trends are evident in his table: a strong association of *Phytoseius* spp. with non-cultivated woody plants, and a relative absence of *Typhlodromus* spp. on ferns, vegetables, and herbs. Later, Amano (1996) briefly discussed the genus-level association of phytoseiids with various prey types, and showed a diet continuum of (plant materials)-(pollen)-(eriophyoid mites)-(spider mites) along the phytoseiid genus line of (*Phytoseius*)-(*Typhlodromus*)-(*Amblyseius*)-(*Phytoseiulus*).

Based on the information available to date and also on new taxonomic arrangement presented in this paper, phytoseiid associations were re-examined. An overall view of the present taxonomic framework suggests a close association of the subfamily Phytoseiinae with stable habitats and also with a prevalent diet such as materials of plant origin on woody plants, with little dependence on animal prey. *Phytoseius nipponicus* is often observed along the main ribs of hairy leaves which host few prey. Members of the tribe Typhlodromini also occur mainly on trees and

bamboo in natural and semi-natural ecosystems, but their diet is more or less animal-based. Throughout Japan, *T. vulgaris* seems to be one of the most dominant species in these habitats when animal prey such as spider mites and eriophyoid mites are relatively abundant.

Concerning lower taxonomic levels, several points should be noted. Among the three subgenera in the genus *Phytoseius*, members of *Euryseius* have a limited distribution in tropical and subtropical regions, and a Japanese species, *P. ikeharai*, is known to occur only in Okinawa. The status of *C. contiguus* is similar; this species was also collected in Okinawa, and other species in this genus are restricted to tropical and subtropical regions of the world. Biological characteristics of species belonging to the subgenus *Euseius* in *Amblyseius* show uniqueness; both *A. finlandicus* and *A. sojaensis* have an important role in natural habitats, attacking eriophyoid mites and sometimes non-webbing spider mites, but they are less adapted for capturing webbing spider mites of the genus *Tetranychus* (e.g., Amano and Chant 1986; Osakabe 1988). A supplementary addition of pollen in their diet may improve their reproductive and developmental rates. In Japan, *A. finlandicus* is common in Hokkaido, and *A. sojaensis* appears abundantly in the warmer regions of Honshu. They often deposit their eggs on the tips of leaf hairs, an uncommon habit among phytoseiid mites.

As mentioned above, the absence of members of the tribe Metaseiulini is an attractive subject to study and it also concerns some biological and economic interests. *Galendromus occidentalis* (Nesbitt) in this group is a dominant species in commercial apple orchards in the western USA and it has been used as a biological control agent throughout the world. In the absence of this species as well as other pesticide-tolerant species such as *A. fallacis* (Garman), the similar niche in Japanese apple and pear orchards is occupied by *A. womersleyi* and *A. californicus* of the subgenus *Neoseiulus*. When sprays are omitted in the orchard, species such as *T. vulgaris*, *T. serrulatus*, *A. orientalis*, *A. sojaensis*, and *A. finlandicus* take over the position in Japan. In other countries, this role is given to *Metaseiulus pomi* (Parrott), *T. pyri* Scheuten, *T. caudiglans* Schuster, and *A. finlandicus* (e.g., Knisley and Swift 1972; Hislop and Prokopy 1979; Amano and Chant 1990).

At even lower taxonomic levels, it is rather difficult to find common biological characteristics possessed exclusively by a particular group. Based on the limited information on the biology of Japanese species, which dominate mainly in agroecosystems, the phytoseiid fauna in Japan was tentatively classified from two different viewpoints: food habits and habitat. Exotic examples are also included in parentheses.

(A) Food habits

- (A-1), species found with web-spinning spider mites such as *Tetranychus* spp:
A. womersleyi, *A. californicus*, and (*P. persimilis*).
- (A-2), species found with less web-spinning spider mites such as *Panonychus* spp:
A. eharai, *T. bambusae*, *T. serrulatus*, and *T. vulgaris*.
- (A-3), species found with eriophyoid mites and other slow-moving prey:
A. barkeri, *A. orientalis*, *A. finlandicus*, *A. sojaensis*, *A. subtropicus*, *P. capitatus*, *P. nipponicus*, *T. serrulatus*, and *T. vulgaris*.
- (A-4), species found with small insects such as thrips and scales:
A. barkeri, *A. okinawanus*, *T. serrulatus*, and (*A. cucumeris*).
- (A-5), species associated with plant material and fungi:

A. okinawanus, *A. sojaensis*, and *P. nipponicus*.

(B) Habitat

(B-1), species on woody plants and herbs:

A. womersleyi, *A. californicus*, *A. paraki*, *A. eharai*, *A. orientalis*, *A. tsugawai*, *A. sojaensis*, and *T. vulgaris*.

(B-2), species on grasses and other lower plants:

A. womersleyi, *A. californicus*, *A. paraki*, *A. okinawanus*, *A. makuwa*, and *A. tsugawai*.

(B-3), species in greenhouses and inside of buildings:

A. barkeri, *I. liturivorus*, and *T. shibai*.

Each species generally has a certain range of food habits and habitat. Thus the authors cannot judge their biology prematurely based on the limited data available, but at least it can be said that phytoseiids in Japan show a remarkable diversity in their food requirement and life types. Further studies on their biology are now in great demand for economic as well as academic reasons.

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